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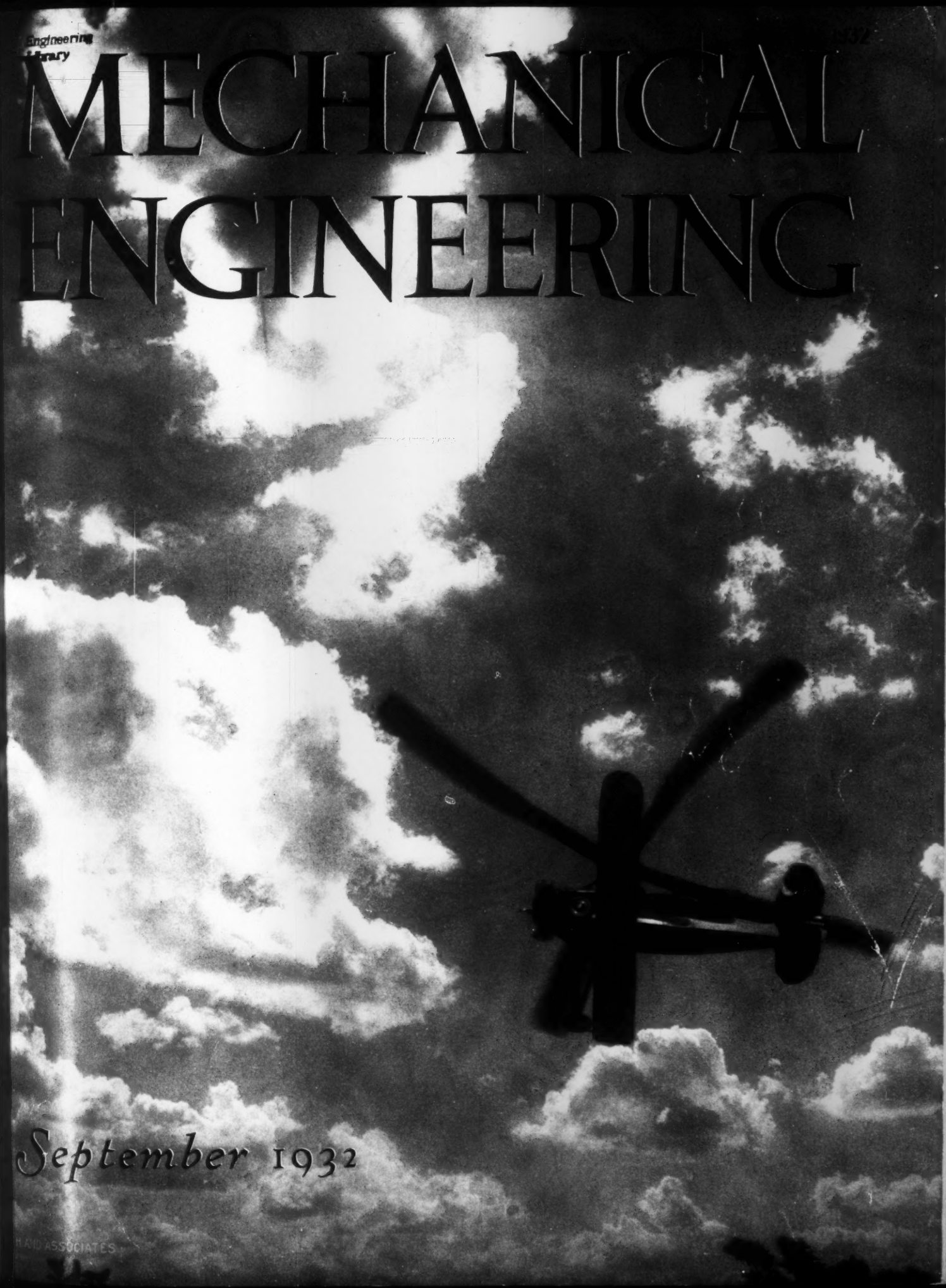
MECHANICAL ENGINEERING



September 1932

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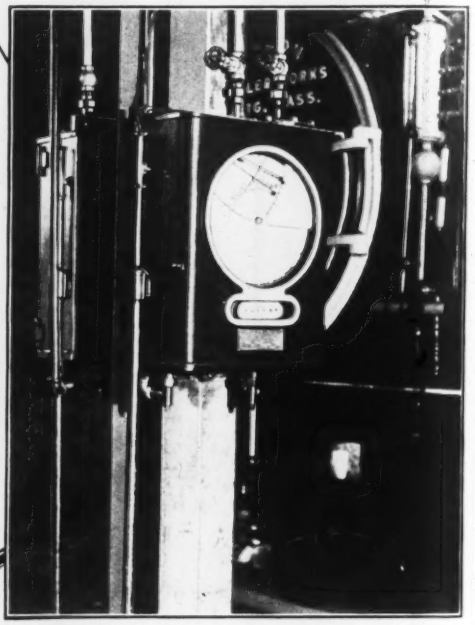

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MECHANICAL ENGINEERING

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WHAT IT'S ALL ABOUT

VISCOUNT CECIL of Chelwood played into our hands this month when he voiced his regret that flying had been invented. The philosophy that prompts such a statement is venerable and has honorable precedents. Unable to believe that a just god could devise so mad and sad a world, primitive peoples imagined their times as the decadent aftermath of happier and more heroic days and fixed upon the discovery of the knowledge of good and evil as the particular cause of a paradise lost. The stealing of that useful but devastating possession of Jove, fire, led to the legend of Prometheus, who suffered everlasting tortures for providing man with this civilizing and destructive element. So also we have reason to regret the efforts of the Chinese to frighten evil-intentioned spirits by means of gun powder, for with whatever sharp spurs to conquest and power this explosive has equipped us, it has also brought added violence and misery into the world. We would be blind to both sides of the picture were we not to recognize the social and economic evils that have accompanied most of the great discoveries and inventions of mankind throughout the ages. Would, for example, that none but men of noble purpose might command the product of the printing press, or that only invigorating and wholesome fruit might be plucked from the tree of knowledge.

ALEXANDER LYMAN HOLLEY, 1832–1882

Honorary member in perpetuity, A.S.M.E., and chairman of the meeting preliminary to its organization, who, in 1863, introduced the Bessemer process of steel manufacture into the United States.

BUT such is not the happy course of human experience as we of today are only too keenly aware. The rapid development of science and technology under democratic institutions has given rise to economic and social changes in which bane and blessing are frequently hopelessly intertwined. It is to be doubted, for instance, if the experimenters at Kitty Hawk had any conception of the complications that their invention would add to the tangled skein of international affairs. It is much more probable that their immediate interest was in conquest and that a secondary consequence was control. Perhaps it is because the first of these is, in its broader aspects, a technological problem and the second a social one that Lord Cecil regrets the success of Wilbur and Orville Wright, as it has undoubtedly been true since the world began that conquest is easier than control.

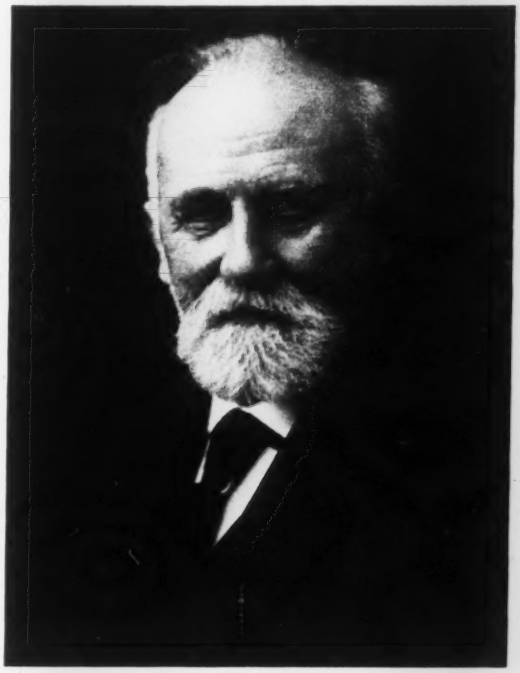
IN their own field engineers are familiar with both of these elements of progress. Thoughtful laymen, as well as engineers, are more concerned with control than they are with conquest. In their mechanical as well as their economic and social aspects the tactics of conquest are more thoroughly understood than are those of control. It is easier to conquer a people than to control their destinies; it is easier to conquer economic and social forces than to control their multilateral effects. To the first of these statements the world conquerors from Alexander to Napoleon could testify; to the second, the times themselves attest.

In any event, it was this thought, so variously expressed in MECHANICAL ENGINEERING this month, that led to the choice of the cover picture with which we have elected to symbolize conquest and control. Most recent of mechanical conquests, aerial navigation has provided serious problems in control.

NO GREATER challenge has confronted engineers and laymen alike in recent times than that which proceeds from the instability of our economic life. With abundant successes in the conquest of the forces and materials of nature, we frequently, as now, find our efforts thwarted and our purposes confused when it comes to effective control of them. The very creatures of our own devising that make us such excellent servants, such as machinery and production technique, are frequently the means through which unexpected and uncontrolled forces work our woe. A growing revolt against *laissez-faire* tactics in the handling of economic matters is evident everywhere. To be able to exercise intelligent control of the powerful but little-understood forces that might serve our ends instead of thwarting them, did we have

understanding, is of vital concern. The orderly procedure of scientific inquiry offers the most hopeful means of acquiring this much-needed knowledge. Following that, education, broadly disseminated, is essential. In this month's MECHANICAL ENGINEERING, Ralph E. Flanders, after a survey of the unbalancing effects of modern production methods and a listing of some hopeful industrial remedies, suggests the attitude and course of action that should prevail in preparing coming generations of engineers for the performance of their serious tasks.

Already there is underway a movement that will assist effectively in the coordination of the efforts of engineers in this direction—the Engineers' Council for Professional Development, announced in an editorial in last month's issue. The underlying philosophy of this movement is skilfully set forth by Mr. C. F. Hirshfeld in an article contributed to this month's issue. Mr. Hirshfeld was active in the preliminary discussion that led up to the formation of the Council and is one of the A.S.M.E. representatives on this newly formed body.



JOHN EDSON SWEET, 1832–1916

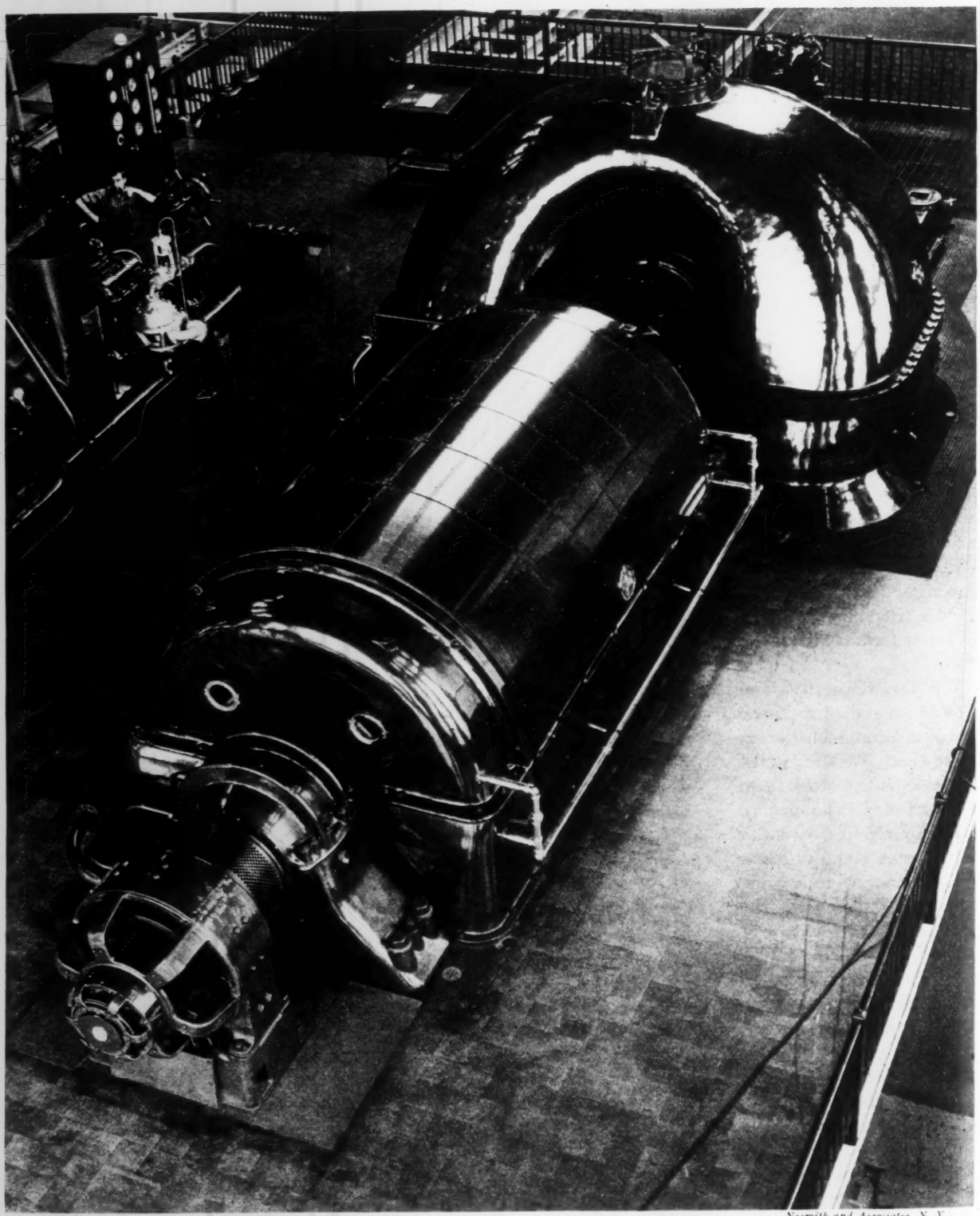
Honorary member in perpetuity, A.S.M.E., and its third president; first professor of practical mechanics at Cornell University and inventor of the "Straight Line" engine; John Fritz medallist.

WRITING in the March issue of MECHANICAL ENGINEERING under the arresting title, "Whose Fault?" Mr. Hirshfeld pointed to sociological and economic research as providing the means whereby we might gain control of our crazily careening civilization. His accusation and his remedy attracted wide attention and provoked much comment. This month, under the title, "Principal or Accessory to the Crime?" Charles Jay Seibert offers a reply to Mr. Hirshfeld's article.

Mr. Seibert possesses the undeniable advantage of physical detachment from our present scene. His Brazilian crow's nest affords him an ampler perspective of the ship and the seas through which it sails and makes him sensitive to veering winds that those on deck are likely to miss. He contrasts the Amazonian jungle and the "sidewalks of New York" and considers the effects of these locales on their inhabitants. His mood, sometimes harsh, generally critical, is reflective and philosophical; and in the end he offers constructive suggestions to those who may wish for action.

MR. SEIBERT lives so far away that we have been unable to send him proofs of his article for correction. In justice to him, therefore, it must be confessed that the illustrations that accompany his article and the captions are included without his knowledge. They represent the advantage of an editor over a contributor. Readers of Mr. Hirshfeld's article may recall that it also was illustrated. This was another case of editorial prerogative, to which Mr. Hirshfeld has as yet offered no rebuke. Mr. Seibert, on the other hand, calls attention to the illustration showing New York City from Governor's Island and takes exception to the caption which reads, "The modern city is a triumph of science and engineering." "Is this true?" he asks, and goes on to say that it would be more apt to describe a modern city as "an agglomeration of examples of triumphs of science and engineering, yielding as a whole an astounding display of misconducted effort and energy." What Mr. Seibert could not know, of course, is that the caption, as originally written, contained the essence of his characterization, but was finally changed so that the article might not be concluded with a minor chord.

IN justification of cities, for which we must confess a sympathetic attachment, a series of illustrations accompanied by extensive captions, not descriptive of them, has been inserted in Mr. Seibert's article. Whether modern cities will, in the future, yield no more than the crumbled clay and jumbled middens that are uncovered in the prehistoric mounds of Asia Minor, cannot be said. It may be the fate of cities to become waste heaps. It may be, as Mr. Seibert suggests, that in the future our cities will lie fallow as, during certain periods of history, cities of other civilizations, made desolate by decadence, have lain. But it seems reasonably certain that, in spite of human weaknesses and present suffering, life in modern cities is being greatly ameliorated and enriched by science and technology, while these same beneficent forces are removing some of the causes for congestion and squalor that have so long been a reproach to ancient as well as modern civilizations.



Nesmith and Associates, N. Y.

Turbo-Generator at Deepwater Power Plant

The ECONOMICS *of* MACHINE PRODUCTION

By RALPH E. FLANDERS[1]

ECONOMICS is not a closed science within itself. It is a method of study, and embodies the results of study, of conditions, forces, and events observed in the world about us. These external data are to be found in numerous fields, as in those of psychology, commerce, finance, and exploration; but no single field is of greater importance than the one to which we devote our lives—that of engineering and engineering management. Aside from the results of geographic exploration (for the present comparatively unimportant) and those of pure science (for which we act as intermediaries), there is no field of human activity which compares with ours in the importance of its reactions on the science of economics.

With these facts in mind, this paper has been written to suggest that the teachers of this subject in our professional schools put themselves in a thoroughly active relationship to it. You are urged not to rest content with receiving passively and from others the analysis of the social effects of our professional activities. Have you not a more useful office to perform on the one hand in interpreting the nature of these influences to your confrères who are not in contact with its sources? On the other hand, will not our students be prepared to play a more effective part in the world if they also are introduced to our generative function in the rapid social and economic changes of our time?

What shall we conclude as to our proper attitude and action, particularly in preparing the coming generation of engineers for performing their serious tasks? May I suggest the following:

1 Imbue them with a firm faith in the effectiveness of what engineers have done, are doing, and will do in producing all the physical requirements for a continuously higher and more stable scale of living, ever more broadly distributed.

2 Teach them to look at the undesirable effects of their work with clear and honest eyes, to the end that they themselves and workers in other fields may the more skilfully cooperate to cure its maladjustments and bring its benefits to full realization.

3 Seek to develop and preserve that necessary balance in thought and action which leads its possessor successfully through the details of his immediate responsibilities, while directing his own general course, and helping to direct the course of society as a whole toward large and worthy ends.

4 Emphasize the responsibilities of the engineering training. It is important to divide justice from injustice; it is equally important to divide the possible from the impossible. Without knowledge of the latter, which is the engineer's own peculiar office, the former will fail of accomplishment.

5 Hold always before the student the vision of this "new and unforetold stage in human development"—the self-conscious direction of the mechanism of economic and social life to ends of general well-being.

UNBALANCING EFFECTS OF MODERN PRODUCTION METHODS

Less and less does it appear that the forces acting in our highly industrialized profit economy operate to effect an automatic stability. Ten serious unbalancing factors are here listed and briefly described.

(1) *Profits and output are unstable under conditions of large fixed charges.*

This is dependent on the change from simple manufacturing conditions in which the fixed costs of manufacture are low and the principal elements are the costs which vary with output (such as those for direct labor and material) to the so-called "mass-production" condition in which the fixed investment is high and the variable labor cost low. In many cases of high-investment production, the sum of taxes, insurance, depreciation, obsolescence, heating, maintenance, bond interest, etc. may be so great that the plant must run at 50 per cent capacity or more before the sales receipts will sufficiently exceed the variable labor and material charges to cover these fixed expenses. Profit, therefore, disappears below 50 per cent production, in spite of the fact that it may be very satisfactory at full production. The 50-per cent mark in this condition is what is often termed the "break-even point."

This is perhaps most plainly seen in the diagram shown in Figs. 1 and 2. Fig. 1 shows a comparatively primitive condition of manufacture, for a mill with a maximum output of $100,000 of goods per month. Under the conditions there shown, with low fixed charges, operations break even at 25 per cent capacity or $25,000 monthly sales and production. Above that point there is a mod-

[1] Vice-President, Jones & Lamson Machine Co., Springfield, Vt. Mem. A.S.M.E.

Presented at the Session on Economics of the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education, Stevens Institute of Technology, Hoboken, New Jersey, July 19, 1932.

erate and slowly increasing profit; below, a similar loss. Fig. 2 represents a modern and well-managed plant in which expensive equipment replaces men and reduces labor cost, while careful design and control of waste, combined with scientific specifications and close buying, reduce the material cost. Here the profits are doubled at full capacity as compared with Fig. 1, but they disappear at half capacity, and the losses multiply below that point.

The sudden appearance of profits at the break-even

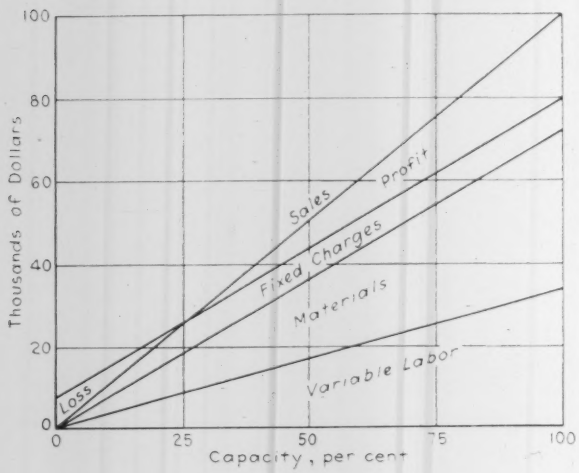


FIG. 1

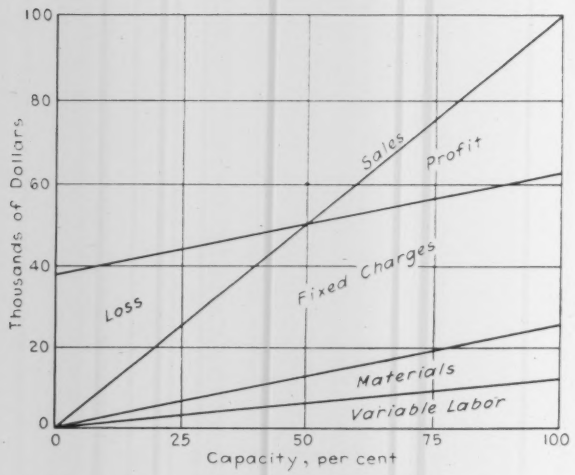


FIG. 2

point, their rapid increase above it, and equally rapid development of losses below, has led to a frantic endeavor on the part of business to keep output above the critical percentage. In many industries this has meant that the total of such efforts gave an output greater than the capacity of the market to absorb it.

Summing up this point, we may say that the modern tendency is for economy in production to depend on capital investment rather than on labor power; and that this results in unstable profits and a tendency for production to exceed effective consumer's demand.

(2) *Highly developed machine production leads to unstable relations between price and volume of output.*

This condition, like the previous one, arises from the effects of high fixed charges. It nullifies the classic assumption that a decrease in production will automatically follow a reduction in price resulting from a decline in effective demand. More briefly, price does not now quickly adjust production to consumption.

The older conditions of low fixed expenses and higher variable expenses did act automatically to a considerable extent. The least efficient manufacturer continued to produce even though the price received gave him no profit, provided it helped him meet his low fixed expenses. But the moment the drop was so great as to make no contribution to these, he withdrew his plant from the total productive capacity. As prices continue to drop, more and more efficient manufacturers approach the marginal condition, lose their profits, and close their shops as they fail to make headway on their fixed expenses.

With modern high-investment plants, however, it is obvious that the large percentage which the fixed charges bear to the total will permit of a very large drop in price before even the least economical producer will be persuaded to go out of production completely. The importance of this change in the relative weight of the labor charges and the fixed expenses was first brought to my attention by Dean Kimball. I have since received a set of diagrams which show the relations very plainly. They were devised by Prof. J. Goudriaan, of the Commercial University of Rotterdam, and were sent to me through the courtesy of Dr. H. S. Person, of the Taylor Society. It will be noted that they have some resemblance to the charts in Figs. 1 and 2.

Fig. 3 shows the conditions of a primitive type of manufacture. With the unit price stabilized for the moment at the top level of the diagram, the costs and profit are shown for each of seven manufacturers, *A*, *B*, *C*, *D*, *E*, *F*, and *G*, of whom it is evident that *A* is the most efficient and *G* the least. Manufacturer *G* is, in fact, making no profit, but is recovering his expenses. If, now, the price goes off to 80 per cent, *A*, *B*, and *C* will continue to make a profit and *D* will make his expenses. Manufacturer *E* will operate at a loss, but will continue since he is making a part of his fixed charges. Manufacturers *F* and *G* have shut down. Should the price go off to 60 per cent, only *A* and *B* would produce.

Under the more modern conditions shown in Fig. 4, a drop in price to 80 per cent leaves them *all* running—three at a profit, one breaking even, and three making more or less on their fixed expenses. When the price drops to 60 per cent, only *G* has been forced to close; the rest, for reasons explained in connection with Figs. 1 and 2, are running as nearly full capacity as they dare to.

Under these conditions in which price has little immediate effect in the volume of production, a drop in prices is intensified and accelerated. It is probable that the disastrous decline in the price level which we have been experiencing is in part based upon this phenomenon.

The considerations just adduced do not, of course, re-

late to the effect of a decrease of price in stimulating consumption. The sluggishness of this normal action at the present time is due to obvious psychological factors.

(3) *Increased efficiency in manufacture, particularly when displacing men by equipment, throws a larger percentage of those gainfully employed into relatively unstable occupations.*

This consideration has perhaps larger implications than appear at first sight. We have been accustomed to refer to the census figures for justification of our belief that technological improvement has not resulted in unemployment. On their face, the figures support this claim, even when analyzed by specialists of the highest repute. On the other hand, individual manufacturers have long been distressed by the fact that selling costs have tended to increase as manufacturing costs have been diminished. We are only beginning to suspect that there is a causal connection between the two.

It is possible that when men are displaced by machines, they tend to obtain reemployment in one of two typical ways: They may anxiously re-insert themselves into the economic machine by engaging themselves as house-to-house salesmen, or by arranging to open unneeded gas stations, for instance; or they may be employed by a manufacturer who is expanding his sales department under the pressure of that necessity for output described under heading (1). In either case the re-engaged worker is employed under more hazardous conditions than are those remaining in the production activities—particularly those producing the staples of subsistence. Here is to be found a probable element of unbalance.

(4) *With increased economy in production of the necessities of life, expansion of industry and commerce is directed toward the provision of comforts, refinements, and luxuries, the demand for which is relatively unstable.*

This condition is so nearly self-evident as not to require extended comment. Of course, the instability of profits, described under heading (1), is doubly unstable in this type of business.

In this connection we must not lose sight of the fact, however, that in the provision of goods which are not necessities lies the whole progress of the material aspect of our civilization. Any program of stabilization which depends on diminishing the spread of these cultural goods falls short of our desirable possibilities.

(5) *The wide-spread and rapid accumulation of profits tends to slow down business activity.*

On the face of it this is a regulative factor, but it can be shown that it works only on extreme swings in the business pendulum and in a way to exaggerate those swings through its effect on speculation, and in other ways.

The action of this factor, while of prime importance, is a little difficult to describe in brief compass. We may begin by saying that it is theoretically possible for society as a whole to have money enough to purchase all that it makes, and that this condition is met continuously as long as the returns from the sales of manufacturing and mercantile establishments are all paid out at the same rate they are received. These payments, going to wages, materials, salaries, replacement, maintenance, supplies, taxes, insurance, interest, dividends, etc., add to the general purchasing power of society just the amount required to dispose of the goods produced.

Under the purely theoretical condition that all the individual and organized elements of society are in this same balance between receipts and expenditures, it is clear that the processes of production would finance consumption. It can furthermore be shown that the same

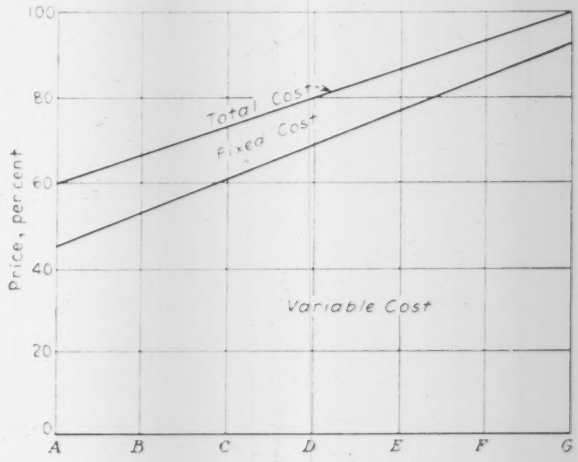


FIG. 3

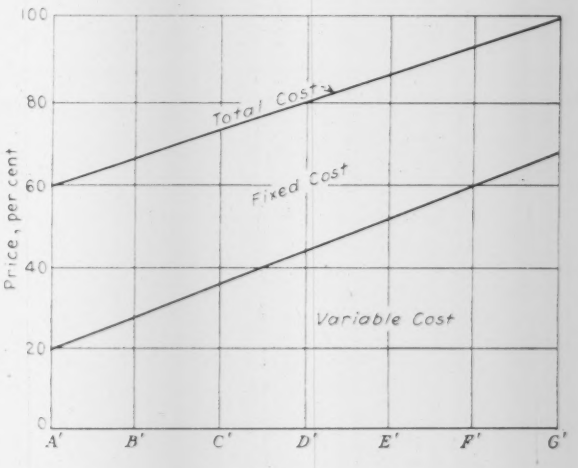


FIG. 4

balance can be maintained during a period of expanding production. On the other hand, it is not directly possible to buy all that is made if the general tendency of individuals and corporations is to save. When, as a whole, income exceeds expenditure, the effective demand for goods must decrease.

This introduces a serious dilemma, for all of the unbalancing forces which have been described, and others not yet mentioned, make saving an elementary act of self-preservation. This act is, indeed, the conventional compensation by which the economic machine seeks to preserve its balance; but if it is in itself a factor of disequilibration, how can it ever have had a useful effect?

The answer is two-fold. In the first place, when savings have to be drawn upon for consumption, on that "rainy day" for which they are laid aside, that use redresses the unbalance previously engendered. Goods which found no purchaser are now disposed of.

The second function of savings is the important one, however. Its most generally useful office is to provide funds for new physical investment—new machinery, buildings, power plants, railroads, ships, or the thousand and one other capital expenditures required by a developing country, an elaborating civilization, and an expanding population. If, through the medium of new investment, savings flow freely into the purchase of capital goods for the above purposes, the act of saving does not diminish purchasing power and business activity is not decreased. Expenditure for capital goods is as effective for this purpose as any other kind of expenditure. Saving may then act as a balancing force for regulating the other factors, without itself setting up uncompensated disturbances.

The disparity between savings and new physical investment was undoubtedly a prime factor, though not the only one, in the events leading to our present distresses. This can be followed in the history of the past decade.

The unparalleled improvements in machinery, processes, and management methods in the period since the war resulted in a large increase in productivity of existing manufacturing plants, whose profitable operation encouraged the building of additional ones. For a time the provision of the improved and additional equipment absorbed the large available profits, furnished employment in the production of capital goods in new investment for labor otherwise displaced, and thus offered a market for the increased flow of consumer goods.

As the provision of new equipment approached saturation, however, the situation changed. Increased output was still maintained and profits were still high, but there were no proportionate increased returns to labor and to those in the lower salaried positions. Nor did those receiving dividends and the higher salaries choose to spend the full amounts received in consumption; they sought further investment instead. There was thus a failure in purchasing power to match the increased production. This situation was masked for a time by the rapid expansion of instalment buying, but became evident when this had been stretched to its limit.

The evident adequacy of existing plants, and the temporarily high returns from their operation, led to a condition in which the purchase of the securities of existing plants was much more attractive than the building of new ones. The vast accumulation of savings, both large and small, was thus directed into speculation instead of new investment. This stimulated the investment-banking business and led to the floating of immense and valueless issues which represented no physical expansion whatever, but merely revaluation of properties at highly inflated levels. Most of the money thus poured into the involved and sterile operations of the financial machinery was lost to purchasing power.

The failure of purchasing power finally resulted in lessened sales and production in the spring of 1929, and this—when it became plainly evident—initiated the inevitable collapse.

This is a crude statement, true in a general way. The effects described were modified by and modified credit expansion, changes in the price level, mass psychological reactions, etc. The balance between savings and physical investment is, however, a primary factor, and one whose importance will increase instead of decreasing as time goes on.

Returning to the statement at the beginning of this heading, it is evident that large profits lead to large savings. They go for the most part into the hands of those who save rather than spend most of their receipts. Money paid in wages and to the lower salaried class is, for obvious reasons, more largely spent than saved. Furthermore, sudden and variable profits in prudent hands tend toward saving, where the same amount steadily received might be more largely spent. In these ways large profits become a disturbing factor, upsetting the balance between savings and investment.

(6) *Economies through managerial efficiency are particularly upsetting to the balance between production and purchasing power.*

Where great changes in production methods took place in the last generation they were commonly dependent on the development of new and more expensive equipment. Industrial progress, under these conditions, furnished a continuing use in investment for the savings derived from that progress. Conditions are quite different in the later developments of industrial efficiency, initiated by Mr. Frederick W. Taylor in the '90's and 1900's.

While believing in and making full use of the latest improvements in mechanism and apparatus, he was particularly concerned with the enormous efficiencies to be obtained by the rational use of that already in existence.

It is safe to say that his principles have had their most rapid expansion in the last decade, and that in that time there has been a great increase in efficiency, resulting in corresponding profits, which, to the extent that it resulted from management policies, has not generated an outlet in any accompanying and corresponding volume of new physical investment.

On the basis of our previous heading, this fact has further disturbed the balance between production and purchasing power.

(7) *There is possibly a permanent slackening of the rate of increase of needed new investment which, by requiring smaller savings, will make large profits a more disturbing problem in the future.*

This is a highly speculative proposition, but is worthy of thought nevertheless. An obvious factor is the slackening of population growth, due to the curtailment of immigration and the inevitable flattening of the curve of natural increase. We shall not need such a large increase of investment in the future to take care of increase in numbers.

Another evident factor is the approach to complete ex-

ploitation of our natural resources, and the rapid development of competing resources in more recently explored parts of the earth.

Less certain is the chance that new invention will flag in its output, or that it will tend to be of such a character as not to demand large investment in its application. Aside from a present tendency of that sort, our only evidence is the trend of development in contemporary science. Its attention and progress are largely centered upon transcendental aspects whose practical application is not immediately evident. Since, ultimately, science, through engineering, generates new outlets for investment, our doubts as to the future may be considered uncertain, but they are not foolish.

A serious and significant fact lends weight to these speculations. This last boom was the first major one within the memory of this generation in which industry as a whole did not receive orders in excess of its capacity. Deliveries were not greatly extended at the peak. It was a "buyers' market" throughout. For the first time we found ourselves with ample equipment and labor fully to meet the extreme demands of a period of unrestrained business enthusiasm.

There is one chance, and it is a large and hopeful one, for a renewed demand for physical investment. This will come if we are wise enough and persistent enough so to recast our economy as to provide increased purchasing power for the many millions who are able and willing to render effective service but find themselves temporarily or permanently outside the charmed circle of intensive production and consumption.

(8) *The businesses and workers dependent on the production of equipment and other capital goods are an unstable element in the effective demand for consumer goods.*

The foregoing analysis of the relation connecting business activity with the balance between savings and new investment emphasizes the instability of the industries producing capital goods. In this respect they resemble the luxury industries described under the fourth of these headings (5).

The decline in capital goods, however, precedes that in luxuries and may be the first intimation of the approach of a recession in business. It has, in fact, been calculated that the recession in business as a whole for the year 1930 could be accounted for by the decrease in the sales of this type of industry, plus the decrease in the sales of consumer goods to those dependent upon it.

If this calculation is correct, it is strong evidence of the importance of the relations between profits, savings, new investment, and the maintenance of prosperity.

(9) *Dependence on foreign investment and foreign trade is a disturbing factor.*

This proposition opens up the highly controversial question as to whether it is best for a country as self-contained as ours to organize its own prosperity in so far as it is possible, or to tie itself by innumerable bonds to the globe as a whole, seeking to find the prosperity of its citizens in the stability of world conditions.

On this question it may with propriety be observed that so far our invasions of the realm of international finance have not been of a kind which has promoted stability.

It may furthermore be argued that the 10 per cent, or thereabout, of our output which goes abroad must not be permitted to be the deciding factor in the maintenance of prosperity. There is far more hope for successful economic control within our borders than for the world as a whole; and there is opportunity for an increased purchase of goods by those of our citizens now living on a scandalously low scale, which will aggregate many times more than the 10-per cent increment derived from our export trade.

Dependence on the home market can be made an element of stability.

(10) *There is a fundamental social instability, translatable into economic terms, in the transfer of large sections of the population from self-sustenance on the soil to dependence on an unreliable industrial organization in urban areas.*

In this factor there is no direct economic effect that has not already been stated in other terms, but there is an indirect one of fateful significance.

This movement from the soil to the factory is a necessary and desirable one *if we can stabilize the factory*. The movement toward industry should, perhaps, meet the emigrating farmer halfway, in rural settlements, rather than herd him into our megalopolitan centers.

We are unbalanced as between the products of the mill and the farm. We raise more food than we can eat; but for the population as a whole we have not made more good clothes than we should wear, better homes than we should live in, or more comforts and luxuries than our character and capacities entitle us to.

The economic aspect is this: As this inexpertly transplanted population increases, and as successive depressions destroy its trust and hope in the mechanism to which it has surrendered its independence, there must eventually be engendered destructive forces of a social or political nature; in which case our economic structure will suffer from sudden assault or from internal disintegration.

This danger is a cumulative one. If "natural processes" of some sort drag us out of this depression, its results will not disappear. They are graven as indelible experiences in the souls of our citizens and will reappear as new patterns of conduct in the social body. The journey we are taking as a people is an irreversible one. It behooves us to give it right direction.

OTHER FACTORS OF ECONOMIC UNBALANCE

These ten varieties of economic unbalance present a rather terrifying picture. And they do not exhaust the list. There are important influences in agriculture, international relations, financial operations, monetary policy, and mass psychology which would enter into any complete statement.

It would be absurd, for instance, to ignore the uncontrolled expansion of bank credit during the inflation, or

the serious aspects of the present self-generating cycle of liquidation and deflation.

These important influences are not discussed here because we are today primarily concerned with the effects of engineering and industrial organization.

METHODS OF BALANCE THROUGH INDUSTRIAL POLICY

We have met with some success in our search for disruptive forces acting within our field. Is it as rich in devices for effective control?

There are a number of remedies strongly urged by management for application within industry. These have a surface appearance of effectiveness. Some of them can be shown to favor the prosperity of the individual firm while being of doubtful usefulness to business as a whole.

In this category must be placed the exhortations to *improved efficiency*, whether in manufacturing or selling. This is almost a religion with the engineer and is necessary for the survival of the individual firm. In addition, it is socially desirable as the foundation for a generally higher scale of living. But our present efficiency is ill absorbed and, without a technique of adjustment, further improvements will multiply our troubles. A larger number of people will be driven into the unstable sales and service occupations or into the equally unstable business of providing novelties and luxuries; these occupations being strained to the limit, many will be thrown completely out of the economic organization. Furthermore, in so far as the improved efficiency is derived from the replacement of men by machines, there will be an accentuation of the unstable profit conditions which arise from an increase in fixed expenses and from the accompanying disruption of relations between price and output.

Another favorite exhortation is directed toward the *building up of reserves, corporate and personal*, during good times. This policy is of undoubted individual usefulness and does not appear to be wholly harmful in its general effect. If pursued on a large scale it would slow up business as profits began to appear by the withdrawal of purchasing power and, as business slowed up, it would again be revived by the spending of these savings—provided they were not too long withheld.

The practical difficulty lies in the use made of the savings in the interim. As was explained earlier, if desirable new physical investment can be found for them, well and good. They will in that case serve to prolong good business for a time. But if profitable investment does not appear, speculation will, and these funds will serve as the basis of an unstable boom of the type with which we are all too familiar. Actual hoarding of these reserves in strong boxes during prosperity is preferable to lending them out on the money market.

The provision and use of *unemployment reserves* have the same advantages and disadvantages as flow from unorganized corporate and personal thrift. If the disadvantages can be minimized by suitable corrective action, the advantages will be emphasized by wide-spread and regularized adoption of this policy, whether voluntarily or by legal enforcement.

Another favorite and dubious proposal is the organization of industry to *adjust production to consumption*. This proposal has its greatest merit in the case of staple products, particularly natural resources, such as oil and coal. It immediately involves prorating of production, with all the perplexing problems of discrimination between efficient and inefficient producers, and ultimately it involves price fixing under governmental control. There is no discernible escape.

The setting up of *an equivalent of the War Industries Board* is the most elaborate form of this proposal. To many minds it is fatally attractive. That organization was effective in controlling our whole industrial mechanism during the serious emergency of war. Why can it not be equally effective in the no less serious emergency of economic disintegration?

On examination, likenesses disappear and difficulties multiply. "During the World War the task was simplified by the fact that there was but one customer—the United States; one object—the winning of the war; unlimited resources—the artificial expansion of credit which goes with war inflation. As contrasted with that simple set of conditions there are now in the United States one hundred and twenty million customers, each with hundreds of separate objectives for enriching his existence and satisfying his needs and desires. Our resources, alas, are limited, whereas those of the nation at war appeared to be limitless. The mechanism which served the earlier occasion will not serve us now."[2]

We are properly loath to give up the freedom and variety which our present system affords us. We have a truly democratic control of the details of industrial production through our dollar votes. These votes—one dollar, one vote—determine which brands of toilet soap shall be largely sold and which shall be discontinued, whether the radio shall displace the phonograph and piano or find a place along with them, and whether or not the country town shall support a movie palace of its own.

There are wastes in the exercise of this dollar voting, as in our political voting. It costs a vast sum to solicit our patronage effectively. But there is a richness and freedom and variety in our choice which we prefer to the standardized products of an economy of planned details, even as we are willing to undergo some of the annoyances of democracy rather than submit to the regimentation in thought and action which a dictatorship, however efficient, would fasten upon us.

SOME HOPEFUL INDUSTRIAL REMEDIES

There has been something the matter with all the remedies proposed thus far and, unless we can do better, we may well fear for our precious, if disorganized, freedom. There is, however, a group of industrial remedies which have a more hopeful aspect.

One lesson in detail we may take to heart is to *avoid industrial bond issues* if possible. When expanding, sell stock, or reinvest surplus. If this policy can be followed,

[2] Progress Report of Committee on Economic Balance of American Engineering Council.

fixed charges will be diminished and the relations between profits, prices, and output will be rendered more stable.

A *stabilized production schedule* for the individual industry can be so applied, in some instances, as to benefit both the individual case and industry as a whole. To be applied effectively this policy requires a staple product, not subject to sudden change or to physical deterioration. The firm applying it must have ample resources, as bank credit may not be available when it is needed. (This, as has been explained, is itself a negative factor.)

The policy is not easily applicable to the production of luxury goods and novelties or most types of capital goods, so it does not improve the situation in those industries which, as we saw earlier, are most subject to unbalance. The best known application so far is in the case of a large manufacturer of soap and shortening. A convincing case has also been made for its application to the steel industry.[3]

For its effect on business as a whole, the accumulation of the necessary financial reserves is probably negative, as has been observed. The stabilizing of employment and thus of consumption is all to the good. And if stable profits will lead to the orderly expenditure of a larger percentage of them, the whole effect is probably favorable.

Relatively complete, accurate, and comparable financial and trade statistics would be highly useful. The former should be demanded and made public by the stock exchange, the latter by the trade associations. If these are not forthcoming through private initiative, they should be forced by governmental pressure.

Reliable, comparable, financial statements, and monthly reports of orders received, cancellations, unfilled orders, shipments, and stocks on hand for all the important industries would diminish the attractiveness of speculation, which feeds on imaginary possibilities. These practices would also discourage unwise expansion whether in output or of capital facilities. This, in turn, would steady the equipment industries which, as we have seen, are normally unsteady. If finally, and more doubtfully, the diminishing of speculative prospects and the doubt as to the necessity for unlimited new investment should lead to a renewed tendency toward the spending of the more stable profits, there will be a favorable effect on the primary unbalance between savings and investment.

When the rate of savings is exceeding the rate of new physical investment, two remedial measures may be taken. Savings may be decreased by increased spending, as suggested above, or we may make *an intensive search for profitable investment*. In the latter case the services of the engineer and of the trained business administrator should be called upon more and more frequently, and these professions should train themselves more carefully for the task as the obvious fields for investment are occupied.

Next to the investment needed to supply our one hundred and twenty millions on an enlarged scale of living, there is perhaps no opportunity which, in the aggregate, equals that offered by the tremendous sum of *minor improvements in machines and processes* throughout industry as a whole. Every shop manager is familiar with many instances in his own plant where the investment of sums ranging from a few hundred to a hundred thousand dollars will return profits that are safe and large; but each case must be carefully analyzed and conservatively estimated. When this is done, these expenditures are usually found to be of a much safer order than many of the larger undertakings for which bond and stock issues are employed.

There is here a chance for pioneer work on the part of financial institutions to develop some recognized way of directing general investment funds into this hopeful field. It requires professional advice and appropriate financial instruments. The transactions are too small for stock or bond issues. There is needed the equivalent of the mortgage in the real-estate field (though of short, definite term) with the same background of acceptance by all parties concerned.

The last industrial expedient which I will mention is that of a *shorter working week*. If this were universally adopted, on a country-wide basis, it might be expected to have a large remedial effect. It would in the first place constitute an initial spread of work, which would palliate the distresses of unemployment. In the second place it would tend to withdraw men from the unstable sales and service occupations into the steadier production activities. Finally, and most important of all, if carried far enough, it would apparently create an artificial shortage of labor which would lead to a larger share for it in the total returns from industry. This, in turn, would lead to a better distribution between spending and saving, and a less uncertain balance between saving and investment, by checking the former and increasing the opportunity for the latter from the increased consumption.

But is this a hopeful possibility? How can we expect industrialists to shorten hours on their own account when it may affect profits unfavorably unless every one does likewise? Will every one do likewise? Especially, how can they be expected voluntarily to carry it to the extreme of causing an artificial labor shortage? As an industrial possibility the outlook for this remedy is dubious indeed!

SUGGESTIONS FOR REMEDIAL ACTION

Of the ten suggested remedies within our field, some are clearly fallacious, others are doubtful, others are of undoubted but limited usefulness, while still others—like this last one of the shorter working week—appear to be difficult of application. If we have nothing better than these to offer, it is time for us to withdraw our attention from our special interests and focus it again on the general body of economic doctrine and data.

To explore completely the possibilities of remedial action is not the purpose of this paper. May I say, nevertheless, that for the present I am inclined to accept a certain group of suggestions which I will describe briefly:

"Our fundamental task is to maintain a purchasing

[3] "Ingots and Jobs," by William Hard, *Survey Graphic*, March, 1932.

power which will absorb a high degree of production, and to spread this purchasing power over the whole body of the population which is able and willing to render effective work in return. To do this requires, as we have seen, that savings should not accumulate faster than new investment will absorb them; or that, alternatively, sterilized savings should be replaced in some way by expanded currency. The second alternative is a dubious one, in that there seems to be no effective way of insuring that the increased funds will find their way into consumption instead of into speculation.

"If the first solution is sought, it will be necessary (*a*) to persuade the holders of unneeded profits to spend them in consumption; or (*b*) more actively to search out profitable investment and to organize more effectively for the flow of savings thereinto; and, as a corollary, to prevent by more rigid "blue-sky laws" financial operations which may be respectable but are inherently sterile; or (*c*) to devise taxation which will divert unneeded profits into desirable social expenditure; or (*d*) to prevent the emergence of unusable profits by lowering the price of the product or by raising wages; or, finally, (*e*) to accomplish the same effect by an arbitrary shortening of labor hours.

"The three latter methods, (*c*), (*d*), and (*e*), involve changes in the distribution of wealth—a process which will eventually have to be faced as opportunities for profitable investment diminish.

"Particularly useful would be a compulsory shorter working week, say forty hours, with cumulatively penalizing overtime rates. It would permit of an initial spead of employment over a larger percentage of the workers, and as business passed the normal, it would help to furnish increased purchasing power to match increased profits, and would put a brake as well on reckless expansion.[4]

"The solution by way of taxation and public expenditure has other possibilities which must be explored. It is a shortsighted and sophomoric prejudice which leads us to demand the balancing of governmental budgets within the fiscal year. Well-managed businesses are run on a long-time budgeting basis, extending over the business cycle; and cities, counties, states, the Federal Government, and the financial agencies with which they deal must be persuaded to follow suit.

"In the course of the business cycle there is a time to borrow and a time to retire indebtedness; there is a time to expand public works and a time to contract them; there is a time to tax and a time to relieve taxation; there is a time to expand the volume of money and a time to contract it. If these various actions are studied and controlled, they will act as effective balances on unemployment, on variations in the price level, on the emergence of sterile profits, and thus on the business cycle itself. Even those bugbears of the distracted citizen, taxation and public expenditure, may by this means become creative elements of the first order in maintaining his individual prosperity; particularly would this be true if the taxation were specially devised to reduce the body of uninvestable savings as they emerge or to direct them into socially desirable forms of expenditures."[5]

[4] Since the above was written, Macmillan's have published a book by Arthur Dahlberg entitled, "Jobs, Machines and Capitalism," in which a shortening of working hours is made out to be the prime essential. It is difficult to disagree with Dahlberg's arguments.

CONCLUSIONS

If our thinking this morning has been of any value, we may perhaps agree that an important part of the forces which disturb society lie within our special purview, and that we and the younger men following us have a special responsibility for them. We may further agree, and with regret, that the remedies at the special disposal of our profession do not go very deep. What shall we conclude as to our proper attitude and action, particularly in preparing the coming generation of engineers for performing their serious tasks? May I suggest the following:

1 Imbue them with a firm faith in the effectiveness of what engineers have done, are doing, and will do in producing all the physical requirements for a continuously higher and more stable scale of living, ever more broadly distributed.

2 Teach them to look at the undesirable effects of their work with clear and honest eyes, to the end that they themselves and workers in other fields may the more skilfully cooperate to cure its maladjustments and bring its benefits to full realization.

3 Seek to develop and preserve that necessary balance in thought and action which leads its possessor successfully through the details of his immediate responsibilities while directing his own general course, and helping to direct the course of society as a whole toward large and worthy ends.

4 Emphasize the responsibilities of the engineering training. It is important to divide justice from injustice; it is equally important to divide the possible from the impossible. Without knowledge of the latter, which is the engineer's own peculiar office, the former will fail of accomplishment.

5 Hold always before the student the vision of this "new and unforetold stage in human development—the self-conscious direction of the mechanism of economic and social life to ends of general well-being. The eye that has caught this vision is satisfied with no other. Unlike the ancient calls to service, it does not demand that we leave our vocations and our businesses. It does not even demand that we transform them to unfamiliar uses. It does require that we divert their impossible and hopeless enterprises into endeavors which will produce the maximum of benefit to workers, management, owners, and the public at large. Such possibilities are inherent in our natural resources, in our human capacities, and in modern technology. To no lesser ends will men of sense and sensibility be willing to devote themselves."[5]

[5] From author's paper, "Limitations and Possibilities of Economic Planning," American Academy of Political and Social Science, Annual Meeting, April 15, 1932.

PRINCIPAL *or* ACCESSORY *to the* CRIME?

A Reply to "Whose Fault?"

By CHARLES JAY SEIBERT[1]

THE MARCH number of MECHANICAL ENGINEERING contains two articles, "Whose Fault?" by C. F. Hirshfeld, and "Industrial Efficiency and Economic Equilibrium," by R. H. McCarthy. In effect the authors of these articles have asked this question: "Is science to be used for benefiting and uplifting humanity, or is it to become an all-conquering weapon in the hands of a despotic and power-mad minority who will utilize it to reduce humanity to an unescapable and permanent state of economic slavery?"

If scientists and engineers will rally to the standard raised by Messrs. Hirshfeld and McCarthy, resolved that science shall and must be used solely for human advancement and individual economic liberty, a time may come when these two essays will rank with Burke's immortal speech before the British Parliament and Lincoln's address at Gettysburg. To drive the lesson further into our mentality, editorial comments in the same number add much encouragement to those of us who are giving serious thought to the matter.

Editorial reference to Mr. Hirshfeld's views as a challenge to every engineer takes equal rank with the warning Mr. Hirshfeld himself has sounded; to which additional strength is added by the statement that there is a "growing demand for men of high character and broad human sympathies and understanding to make up the profession of engineering."

WHO IS TO BLAME?

While I cannot combat Mr. Hirshfeld's indictment, I cannot refrain from raising the question of blame, for the reason that scientists and engineers have, in the majority of cases, been denied the right to control the economic effects of what they have created through the application of their scientific knowledge and inventive ability.

Possibly the warning issued by Bertrand Russell some years prior to the economic avalanche that is overwhelming us may serve to make my meaning clear. Bertrand Russell wrote: "I am compelled to read that science will be used to promote the power of dominant groups rather than to make men happy. The men who administer the science of the future will have a power beyond the dreams of the Jesuits, but there is no reason to suppose that they will have more sense than men who control education today.

"(The power to dominate and control) technical scientific knowledge does not make men sensible in their aims, and administrators in the future will be presumably no less stupid and no less prejudiced than they are at present. Furthermore, science enables the holders of power to realize their purposes more fully than they could otherwise do. If their purposes are good, this is a gain; if they are evil, it is a loss. In the present age it seems that the purposes of the power holders are, in the main, evil. Therefore, at present, science does harm by increasing the power of rulers. Science is no substitute for virtue." The parenthetical clause is mine.

Reverting to the conclusions of no less personage than Thomas Jefferson, we find that Woodward, in his "George Washington," wrote: "He (Jefferson) was a pure blooded believer in democracy, nay more . . . he was a humanitarian. He saw clearly that all wealth comes from labour, and that the history of the world is nothing more than a history of ruling class schemes to trick labour out of its economic rights . . . and to that end all the institutions of civilization are turned . . . churches, schools, literature, finance, commerce, morals."

ENGINEERS ARE NOT THE HOLDERS OF POWER

The question I wish to ask is, "Who are the 'holders of power' that Russell mentions and the 'ruling classes' that Woodward concludes were in Jefferson's mind?" Surely not scientists and engineers. They do not, unaided, bring into being the machinery which today is being blamed for throwing men out of work. On the contrary, I believe that if engineers dominated, we would, today, all be as busy as beavers. The engineer worthy of the name is too often a humanitarian and an idealist. Engineers conceive and create machines not to throw men out of work, but to abolish cruel and debasing corporal labor, to create greater safety for all of us, to abolish conditions that shorten human life, and to increase productivity per man-hour for those workers in industry and commerce who toil at routine tasks. If engineers constituted the "ruling class," they would, in considering a mechanical aid to human effort, probably strike a financial balance and insist that labor benefit as much as possible by shortened hours of work or an increase in pay rates for production. But it does not

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CONGESTION, SQUALOR, DISEASE, AND CRIME HAVE BEEN TYPICAL OF THE CITIES OF ALL CIVILIZATIONS, ANCIENT AS WELL AS MODERN

The gregariousness of man, the ties of family, tribe, and race, the necessity of self-protection, the prolification of incompetents, the demands of commerce and social intercourse, the enslavement of masses to the purposes of war and political and industrial enterprises, built up Nineveh, Thebes, Alexandria, Athens, Byzantium, Rome, and the great towns of medieval Europe, as well as the cities of China and India and the modern metropolitan centers of the Western World. With the progress of time, science and engineering have ameliorated the lot of those who dwell in these congested districts.

work out this way because in such matters it is no longer the engineer who dictates. The engineer's authority is usually restricted to the production end of industry, and the handling and disposal of the results of production passes into other hands—the distribution and administrative branches.

It has been stated repeatedly in recent years that the efficiency of production has reached a point where it far surpasses the efficiency of distribution. This must not be accepted as being universally the case, for I am sure that all of us know that there are some organizations in which the distribution of the product is marketed in an economical and efficient manner; nevertheless it is certain that too often the distribution is burdened with an expense out of all proportion to the cost to the consumer, the cost of production, and the return on the capital invested in producing plant. It has sometimes occurred to me that the expenses, commissions, bonus, etc., of the gradually growing corps of "contact men" and aides-de-camp of like nature attached to the marketing division of industry must constitute a considerable burden on business and on the consumer, and it is possible that in the attempt to meet competition, the personnel of the production end does not benefit in any appreciable degree by the result of scientific and engineering effort. Too often, when competition must be met, it is to the engineer that the order comes to reduce costs, and he is forced to obey by using the immediate means at his command, in the same spirit that Lord Cardigan obeyed at Balakava. He may be the *deus ex machina* but he is rarely the devil in it.

BUSINESS EXECUTIVES SHARE THE BLAME

The third branch of industry is the administrative division, which embraces the general executives. It is from this branch that the general orders and policies emanate, and in the last analysis it is this division that really rules. Sometimes this division is admirable. My belief is that the executives of our large railways are outstanding examples of the best that can be produced under present-day conditions. In spite of the critical conditions in which the railways find themselves enmeshed, through causes not of their making, a spirit of mutual respect and good-will seems to exist between the administrative and other divisions of the industry. To the man in the street, the remuneration of the railway executives may seem large, but in reality it is very reasonable in view of the responsibility these men carry and accept. Incidentally, the manner in which they discharge the duties entrusted to them, and the stewardships of the properties under their command, is under closer scrutiny than even the actions of the Chief Executive of the country.

A large majority of railway executives entered the service as engineers or employees of the operating or construction departments and they are masters of the details of almost everything pertaining to the business in which they are engaged. But in other industries it will be found that, in a large number of cases, men of legal and accountancy training rule. They base their judgments on balance sheets and statistics and are misled, very often, by those who stand between them and actualities.

In this connection *The Magazine of Wall Street* has shown considerable courage in publishing very plain-spoken discussions and constructive criticisms of the shortcomings of this class of officials who are a very

great power in our industrial and business world. It is this type of man who frequently deliberately orders the installation of machinery, not with the idea of efficiency, but so that human beings will be eliminated from the industry. The fact of the matter is that these men fear to deal with other men when they have to deal with them as collective bodies. Their main idea is to divide and rule. They are the exponents of centralized authority carried to the *n*th power, and their idea of organization means all power centralized in the hands of one man. To them the engineer is often a tool which they must use to execute their purpose, in case their purpose involves the use of engineering or science. This is the type of man who sometimes boasts that he can hire brains. I do not by any means intend to convey the impression that I think that all executives of non-technical training are of the type described, but I do wish to state explicitly that their occurrence is frequently to be found and I think that, because of the autocratic power they hold, they may possibly have been at least as instrumental in helping to create the state of affairs that Mr. Hirshfeld pictures as the engineers and scientists.

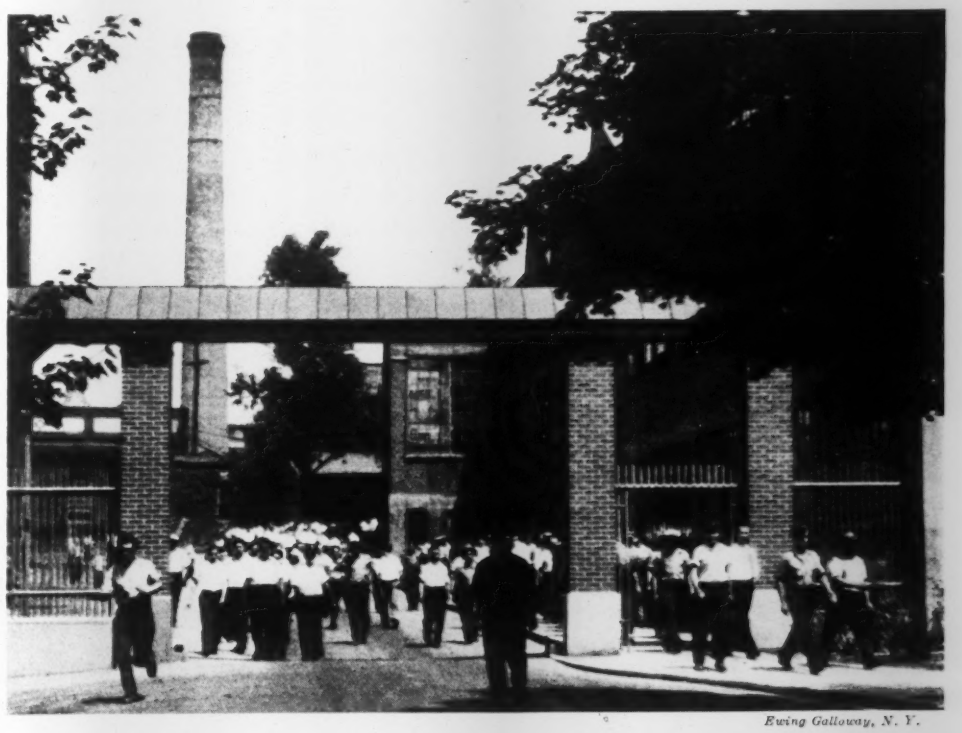
Turning our fog-penetrating ray in another direction, we find in a recent review in the columns of *Engineering News-Record*, the following statements concerning a book by the well-known writer, John T. Flynn: "Far more impressive (than the matters discussed in the first part of the book) is . . . the ethical laxity now tolerated among directors and officers of corporations.

"In theory these men represent the individual stockholders and act always with their best interests at heart. In practice, however, there is a regrettable tendency to subordinate the welfare of a scattered, and for all practical purposes, impotent constituency to the profits of powerful factions and individuals whose financial interests in the corporation may be negligible. The rapid growth of holding companies and interlocking directorates has aggravated the condition. In proof of his contention the author presents specific cases giving names, dates, and places. Most of these have come to light as the result of chance, a fact that causes the reader to wonder just how effective our boasted business honesty may be. Although the unthinking may consider Mr. Flynn a modern Don Quixote tilting at windmills, those conscious of matters as they really are will find in the book much perturbing and pertinent criticism of the existing order."

HAVE SCIENCE AND ENGINEERING BEEN MISAPPLIED?

I would hesitate to write these lines and call attention to the possibility that the administrative and executive class of our large corporations is guilty of such shortcomings as Mr. Flynn describes were it not for the fact that W. B. Donham, Dean of the Harvard School of Business Administration, has written a book, "Business Adrift," in which he, in polished language, paints a picture which H. G. Wells discusses, in words of one syllable, in a recent magazine article entitled, "What Will the World Be Like Fifty Years From Now?"

Years ago, as a student of civil engineering at the Rensselaer Polytechnic Institute, I was taught the elements of geology by Professor Clark, at that time geologist for the State of New York. As I remember his explanation of biological progress, we were the trunk of the tree of evolution, and all other living creatures were merely branches who had developed in



Ewing Galloway, N. Y.

FACTORIES HAVE PLAYED AN ACTIVE PART IN THE DEVELOPMENT OF CITIES

The advent of the factory during the industrial revolution, in which the possibilities of a power-sustained world were first exploited, brought added ugliness and misery to city dwellers and packed even more closely together the countless workers who were drawn into the unsanitary and congested districts that surrounded the sources of power. But today science and engineering are combating the evils of the industrial system and are removing the curse of factory and city, decentralizing congested districts by means of modern transportation and communication facilities. The modern factory is a pleasant work place. Its workers need not live within its shadow, nor in crowded cities, and, because of labor-saving machinery, they are not bowed and broken by the day's work.

other ways. Will the "cloud," which Mr. Hirshfeld so graphically describes, finally wrap us in complete darkness, throw us off our course, and make us a mere branch also? Do our present difficulties presage a stopping of the growth of the trunk of the tree? Or does the cloud merely presage that Europe and North America are approaching a period during which they must lie fallow, while the sap that feeds the tree of evolution will be drawn from the soil of South America?

Mr. Hirshfeld says: "Scientists and appliers of science have brought about a very pretty mess because they were content to do the thing that was comparatively easy." How about those who have deliberately exploited the scientists and engineers? Immediately under the above quotation from Mr. Hirshfeld's article there appears a picture of lower Manhattan as seen from Governor's Island. Beneath this picture I read: "The Modern City Is a Triumph of Science and Engineering." Is this true? Would it not be more apt to describe a modern city as an agglomeration of examples of triumphs of science and engineering, yielding as a whole an astounding display of misconducted effort and energy? Have engineers been responsible for the insane huddling of huge masses of humanity into restricted areas? Is there not some pressure bearing down on engineers that forces them to use their art and science to pile complication on complication?

EVILS OF CONGESTED CITIES

Frankly, I look with suspicion and fear on huge cities. It is not the high buildings, the exchanges, the factories, the power plants, the congested streets, the big rail terminals, nor the hurrying crowds that affect me. It is the dismal, sunless canyons, flanked by drab apartment houses and tenements, the monotonous streets, the lack of horizon, the complete artificiality of everything that oppresses me.

About a year ago I paid a visit to the George Washington bridge. What a beautiful thing it is! How science, art, and craftsmanship, have been skilfully combined in this structure. A distinct addition to the natural surroundings; and yet something created for strictly ultilitarian purposes. I thought: "What marvelous progress we are making. Why, it was really not so long ago that Hendrik Hudson sailed over the very spot where this creation of Ammann and his co-workers now throws its shadow. I wonder what would be Hudson's reaction if he could revisit Manhattan?" But as I left the bridge and walked eastward through the neighboring streets, other thoughts came to my mind and my exhileration gave way to depression. I entered a zone of pale sickly light and found myself traversing semi-dark chasms, bounded by towering walls of dingy brick and dusty terra-cotta. Pallid children played in a half-hearted manner with effete toys, their only playground being the desert of asphalt and cement that we have attempted to glorify in a song called "The Side Walks of New York." If in the future New York develops a race of wall-eyed citizens there will be a reason.

Into my mind there came a picture of other children. Children that shot fish and turtles with weapons of their own making; that played at work rather than worked at play. I saw deep, silent, sun-lit waterways threading their way through hundreds of tree-covered islands that lie just west of the island of Marajó in the mouth of the Amazon. Again I could see little human beings, their naked brown bodies glistening in the sunlight, come racing down to the end of some crude jetty, and standing there, thumb their noses in good-natured derision at the gold-braided officers on the bridge of our steamer. More often than not some normally dour native of Lancashire or Cornwall would wave his brass-bound cap and reply with a quick pull at the whistle cord. How those children would clap, and laugh, and wave their hands. If the cloud overwhelms us, will the descendents of these children of the forest escape and build a new and more rational civilization?

SOCIOLOGICAL RESEARCH IS DIFFICULT

Mr. Hirshfeld ends his thesis with these words: "I am satisfied that . . . we can do much . . . if we will make an honest attempt to apply the research method to the solution of that large class of problems involving huge masses of people."

With that idea I am in complete accord, but may I ask who is to classify, interpret, and put to use the conclusions from such research? How can the results of such research be put to practical use and bring about the desired results?

Synthesis, analysis, experimentation, mathematics, chemistry, a reasoning from cause to effect and vice-versa, systematic observation; all these things society permits, even aids us to use as long as we confine ourselves to dealing with and controlling the basic elements and forces of nature. But when research begins to tear aside the veil that covers the real reasons for our economic and social ills, we are going to have a terrific battle on our hands for somebody is going to be hurt.

I am very much afraid that the result of research such as Mr. Hirshfeld proposes will soon uncover the fact that human greed and avarice and a dangerous lust for power are the main causes of our ills. When we reach this point, the thoughtless usually throw up the sponge and say, "You cannot eradicate that."

I am not so sure that this is true. A good many things have been eradicated since the world began to spin on its axis. If Mr. Hirshfeld's research scheme can be put on a working basis it may demonstrate so clearly what our real trouble is that even the blind may see the way out and profit by it.

SOME CONSTRUCTIVE SUGGESTIONS

So far I have indulged in some pretty destructive criticism. Suppose we shift to the constructive side and ask, "How are we to begin this research?"

As a constructive beginning I suggest that as many engineers as are interested in the subject (and if you are the men I think you are you will all be interested in it) secure a copy of Dean Donham's book, "Business Adrift," and study it, not merely read it but study it.

After that, take the January number of MECHANICAL ENGINEERING and study his essay, "Twenty-Year Plans." I have been looking for comments on that essay and have been a little disappointed on not finding any. I call attention to the following extract from that masterpiece of clear thinking: "In my judgement we should set up a general thinking body, an Economic General Staff, with no control or espionage power, containing men chosen by representatives of the Government, of industry, and of labor. One most important job of this Economic General Staff should be to study the principal shocks to which society is subject and to recommend elastic institutions or programs which will meet these shocks as nearly automatically and with as little delay as possible whenever they occur from any series of causes. Such a body would be futile or dangerous if given control. Society would either lose its vitality or, more probably, develop automatic and peculiarly extra-legal defense mechanisms to boot-leg discretion back to industry. Espionage powers given to such a body would be unfortunate, for they would, through the development of fear, prevent the growth of influence. This Economic General Staff should include a *business research and interpretative division constantly studying general business problems and interpreting them.* The function of such a division should be to give intelligent bases for business decisions."

Is this not, in effect, what Mr. Hirshfeld calls for? That such an Economic General Staff can be called into being I have not the slightest doubt if the engineering profession will take it up and go after the matter in deadly earnest. In the words of our old copy books, "Now is the time for all good men and true to come to the support of their party." We may have trouble in finding the good men and true as so many of us cannot give up our daily search for bread and butter to devote the necessary time to the matter. It is going to be no part-time job. But I am sure that among engineers there are men, and men of unimpeachable integrity, who can devote themselves completely to this work. Once we can get a thing like this started and begin to show results, men from other walks of life will come into our camp; and powerful men at that. This cloud is something that threatens us all, rich and poor, and many a man of wealth today simply hangs on to old methods because he feels that he has the bull by the tail and cannot let go. He is afraid to call for help because he is afraid that he will upset the apple cart while inwardly he is praying that some one will pluck up sufficient courage to seize the wild animal by the horns.

In times past The American Society of Mechanical Engineers has organized committees for various purposes and I have never heard of one that was not successful and did not accomplish what it set out to do. Can we not draw on our past experience in getting this matter organized and operating? If we can, and the research which both Dean Donham and Mr. Hirshfeld are apparently unanimous in believing to be a permanent way out of our ills proves to be the means of banishing the cloud forever, could we ask for any better reward than to have posterity say of the engineers, "They sought and found eternal good for mankind?"

NOTE: Mr. Seibert's "reply" was written before the report of the American Engineering Council's Committee on the Relation of Consumption, Production, and Distribution had reached him. Readers of MECHANICAL ENGINEERING will recall that this report, printed in the July issue under the title of "The Balancing of Economic Forces," bore evidence of a serious attempt on the part of engineers to attack social and economic problems.—EDITOR

Ernestine Shepard

CITIES ARE WHAT MEN MAKE THEM

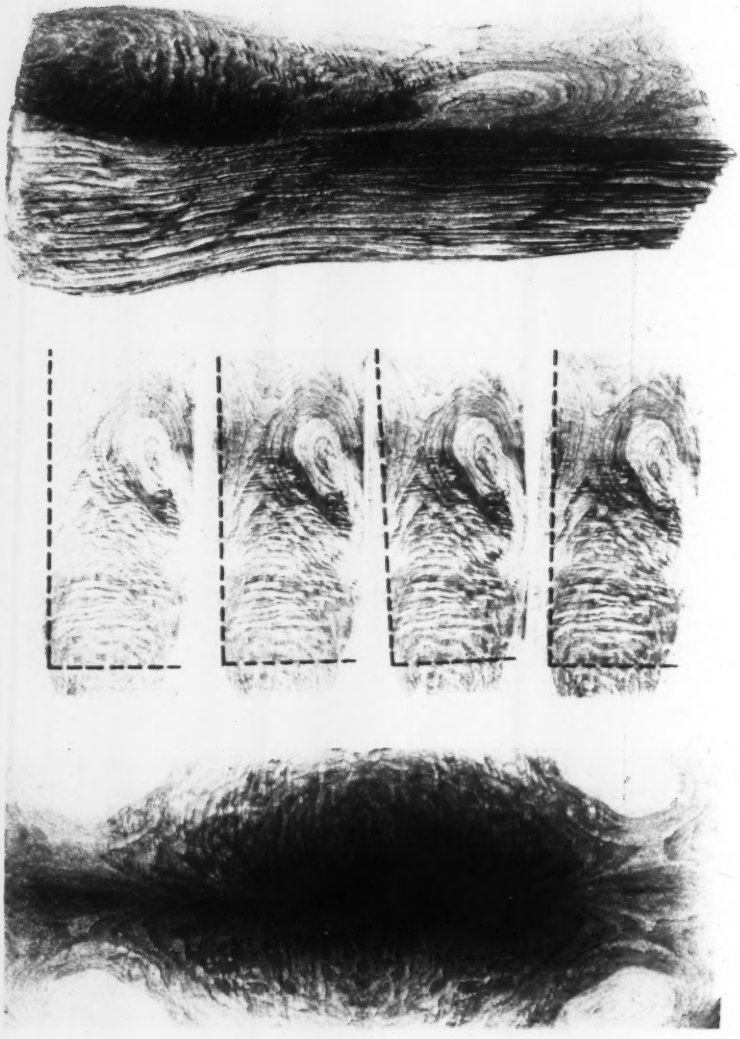
The beauty of cities that build themselves more stately structures is an earnest of the future. Science and engineering provide the means by which they may rid themselves of the reproaches which critics for centuries have heaped upon them and because of which their prophets have railed and wept. The ugly contrast of the marble temples on the Acropolis and the mud huts of Athens becomes less harsh as generation after generation adapt the benefits of science and engineering to the well-being of mankind.

PLYWOOD: *A Product of Unusual Possibilities*

By THOMAS D. PERRY[1]

THE historic uses of veneer, dating back to the Pharaonic dynasties of Egypt, were chiefly those of the overlaying of rigid bases of solid wood with the beautiful although thin and fragile sheets of wood and metal, artistically combined in color and grain effects. Only within the last decade or two, however, has veneer been made up into plywood and in this form utilized in a wide range of industries where the unusual strength and economic factors possessed by this material have made its use practicable and often imperative.

In ordinary trade parlance, "plywood" is a fabricated wood product in which sheets of veneer are combined with each other, or with lumber, with the grain of the adjacent sheets crossing, according to strength and thickness requirements. The term "laminated" wood refers more particularly to layers of lumber (rather than veneer) that are glued, nailed, screwed, strapped, or bolted together, sometimes with the grains at an angle to each other, but more frequently parallel.



PLYWOOD TABLE TOP FROM STUMP WALNUT

(*Upper*, a flitch of stump walnut with sheets piled consecutively as cut. *Center*, four adjacent sheets of veneer, indicating clipping lines for 4-way butt joint in center of top below. *Lower*, complete top, with symmetrical veneer figure, the result of cutting and laying the sheets of veneer shown above.)

ADVANTAGES OF PLYWOOD

The gluing together of thin sheets of wood or veneer, with or without a lumber foundation, provides a material that has many unusual advantages, not only for decorative but for utilitarian purposes as well.

Wood is weakest across the grain; and not only does it split easily, but under exposure to water or water vapor it may shrink or swell up to 10 per cent of its dry width and thickness, while the lengthwise variation under the same conditions is negligible. Plywood, with alternately crossed grains in adjacent sheets or plies of veneer or lumber, provides a wood material of approximately uniform strength in all directions and whose strength characteristics decidedly surpass those of synthetic wood-fiber products.

Not only does plywood construction balance the strength of wood, but it substantially augments the strength of solid wood. It has been repeatedly demonstrated that, on an equal weight basis, multiple plywood made of selected spruce provides greater strength than does steel in airplane construction, both materials being used in their most efficient form for bearing the stresses in the structure.

This advantage of balanced and increased wood strength is inherent in all types of plywood, and when grasped by skilled designers permits many useful developments.

Manufacturers of furniture, pianos, and radio cabinets were early users of plywood because they demonstrated that construction units made of it would not shrink or swell to any appreciable degree. They also found that

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with plywood they could create beautiful furniture for general use at reasonable prices.

Furthermore, a piece of plywood made of three or five sheets of veneer aggregating 1/4 in. or more in thickness cannot be split, torn, or broken without great difficulty. This non-splitting quality of plywood provides nail- and screw-holding properties that are far superior to those of solid wood or of fiber-board products. Screw and nail heads will not pull through plywood as easily as through solid wood, because the adjacent layers are rigidly held by the glue and do not spread.

Plywood can be bent in curved shapes of maximum strength without exposing an unreasonable amount of end grain (as in cutting curves from solid wood) which results in inevitable structural weakness as well as darkening of finish. Plywood can be shaped around a wide range of forms, rolled between heated rollers like steel boiler sheets, or pressed between dies, while the glue is still damp, to provide rigid and smooth curved surfaces with only side grain exposure. Familiar examples are grand-piano rims, opera chairs and seats, serpentine drawer fronts, and cylindrical columns.

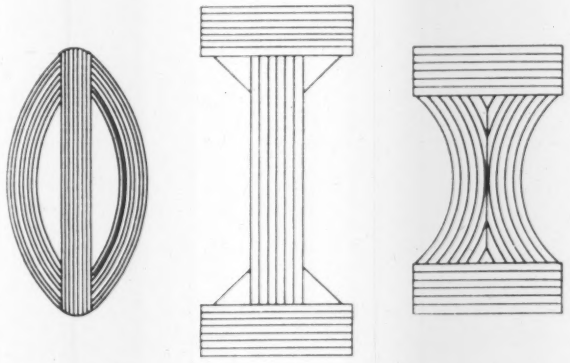

FIG. 1 A FEW SHAPES OF STRUTS AND I-BEAMS THAT CAN BE MADE OF FLAT AND CURVED PLYWOOD

FIG. 2 AUTOMOBILE BODY UNIT

Roof bow made of 1/4-in. plywood bent in forms during gluing with casein. Courtesy Mengel Body Company.)

MODERN WOOD ADHESIVES

Experience in selecting, mixing, and applying glues has developed to a point where a properly made glue joint is stronger than the wood itself. The water-resistant properties of certain glues have been so improved that continuous exposure to the elements and even soaking in water will not cause the glue to soften or the glue joint to separate, except and when the wood itself tears away from the glue joint, owing to its normal and inherent tendency to expand under excessive moisture.

ARTISTIC USES OF PLYWOOD

An extraordinary range of effects may be secured by a skilful combination of beautifully figured veneer grain on a substantial base of stronger woods. The illustration on the first page of this article shows the form in which a flitch of veneer is received at the plywood factory, and the beautiful four-piece butt-matched plywood panel which was produced by skilful matching. It would not be possible to secure these beautiful effects in solid wood, since the beauty of wood consists largely in cutting across the grain at various angles to reveal design, depth, and color. A solid board cut to reveal the same figure would check, warp, twist, and distort to such a degree that it could not be used.

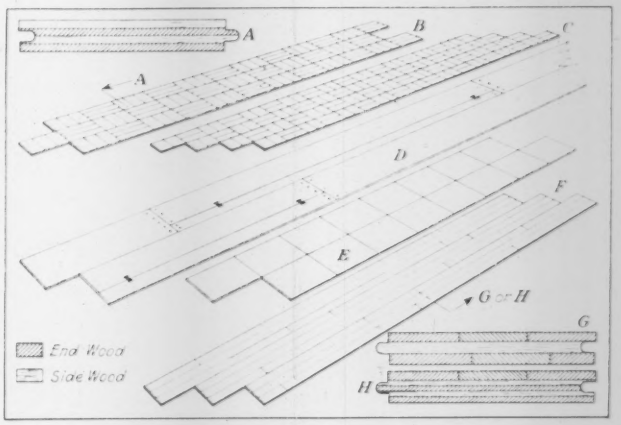

FIG. 3 STANDARD PREFINISHED PLYWOOD FLOORING

A—4-ply parquetry in cross-section, segment-sawn face on a 3-ply foundation.
B—6-in. parquetry squares in standard 6-ft lengths.
C—4-in. parquetry squares in standard 6-ft lengths.
D—random plank with plugs and butterfly connectors.
E—plank parquet, 9-in. squares.
F—standard strip plank in 6-in. widths, 8 ft long.
G—3-ply strip plank in cross-section, with re-sawn lumber back and crossings.
H—5-ply strip plank in cross-section, with veneer foundation and segment-sawn face.

UTILITARIAN APPLICATIONS OF PLYWOOD

Modern plywood has been rapidly growing in popularity and its field of usefulness has been widening.

In the construction of airplanes, for example, the strength-weight ratio of skilfully proportioned spruce plywood has appealed to designers who carefully gage the weight of a material in relation to its strength. Because of its favorable properties, plywood may serve for struts, braces, wing beams, and the like, wherever resistance to compression, contortion, and transverse tension is necessary. Suggested shapes are shown in Fig. 1. Very thin plywood has been found serviceable for wing coverings and fuselage bodies. The opportunity to use curved plywood and built-up structural plywood shapes in the airplane industry has hardly been explored as yet.

The wooden frames of automobile bodies have a

certain resiliency and elasticity that apparently cannot be duplicated in metal.

At the present time laminated wood and scarfed joints are widely employed in the body-building industry, and extensive research is being devoted to a greater use of curved (see Fig. 2) and scarfed plywood to provide the various irregular shapes necessary in streamline bodies without sacrificing strength or safety.

Plywood has been used successfully for partitions or bulkheads in passenger vessels. Partitions between staterooms are rather large in area and can be supported best from the floor and ceiling, preferably without

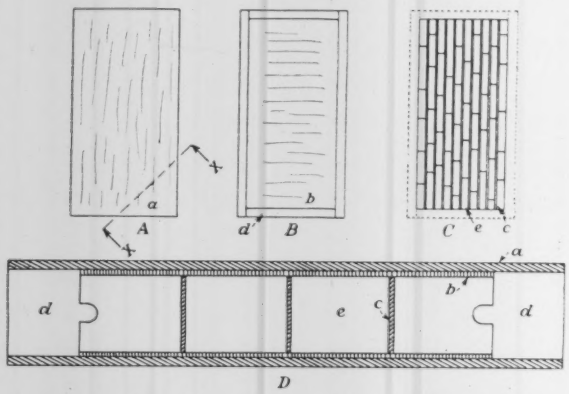

FIG. 4 FLUSH OR SLAB DOOR OF PLYWOOD

A—Flat view of door, showing endwise grain of face veneer.
B—Same view before applying face veneer, showing crosswise grain of cross-band veneer, as well as edge bands or rails.
C—Same view, below crossband, showing core construction before railing.
D—Enlarged cross-section on line *X-X* showing details of construction.
(*a*) Face veneer, usually $^1/_8$ in. thick.
(*b*) Crossband veneer, usually $^1/_{16}$ in. thick.
(*c*) Reinforcing core strips of veneer, also used as glue-spreading media.
(*d*) Protective rails or bands to match face veneer.
(*e*) Core blocks, approximately $1^1/_8 \times 1^1/_8$ in., usually of pine.

intermediate members. Plywood $^5/_8$ in. to $^{13}/_{16}$ in. thick can be bent or twisted to suit the conditions met within the ship. Plywood bulkheads can be made as large as 12 ft × 6 ft, and in some instances even larger, where required. The outside surface may be of figured wood for a natural finish, or of common veneers if paint and enamel are to be applied.

Inexpensive grades of plywood are displacing solid lumber for sub-floors and for interior and exterior sheathing. The bracing effect of the sheets of plywood is markedly greater than that of single boards, even when laid with tongues and grooves. Plaster, paint, stucco, brick, and other finishes can be placed directly on or against this plywood.

Within the last year a merchantable plywood flooring has been developed in which the shrinking and swelling characteristics of solid wood have been greatly reduced. Plywood flooring makes it possible to build rectangular parquet flooring in standard-length boards, some 6 or 8 ft in length, with standardized widths. Some of the possibilities in plywood flooring are shown in Fig. 3.

Not only has plywood construction in flooring made it possible to eliminate many mechanical and economic defects, but it has also permitted prefinishing it by machine before laying, in the same way that furniture and interior fittings are customarily prefinished in the factory before installation.

Most standard-sized doors, except those of the cheaper grades, are made of plywood to reduce shrinkage, swelling, and warpage to a minimum, and to increase sturdiness and fire resistance.

Flush doors, the construction of which is shown in Fig. 4, are standard for hospitals, schools, court houses, and other locations where ruggedness, sound deadening, and fire resistance are essential. The pine-block core construction is especially important, since the smaller the block, within reason, the less tendency there is for the core to warp and wind. The alternating continuous veneer strips between the core blocks not only serve for reinforcement, but are also a convenient means of spreading glue in the joints between the blocks.

Panel doors are usually made of plywood, as shown in Fig. 5. The stiles and rails are made up separately and machined before framing and assembly with the panels. Only one standard type is shown.

If "coming events cast their shadows before," it is reasonably safe to predict that in the future large areas

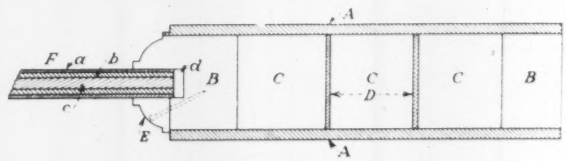

FIG. 5 PANEL OR STILE AND RAIL DOOR OF PLYWOOD

A—Face veneer on stile or rail, usually $^1/_8$ in.
B—Edge strips on stile or rail, to match face veneer *A*.
C—Core strips, usually of pine.
D—Reinforcing core strips of veneer.
E—Molding to hold panel.
F—Plywood panel, 5-ply.
(*a*) Face veneer.
(*b*) Crossing.
(*c*) Veneer core.
(*d*) Clearance space.

of forms for holding concrete during hardening and drying will be made of plywood rather than of solid lumber. The conventional method of building wooden forms with an excessive amount of studding, nailing, bracing, and wiring, may be superseded by the use of large sheets of the cheaper grades of plywood. These grades come in sizes as large as 8 ft × 16 ft, and can be anchored and braced with much less labor and accessory material than ordinary boards. The smooth appearance of concrete, when the forms are removed, offers a considerable advantage. (See Fig. 6.) Plywood concrete forms can be used as many as twenty times, a far better record than that held by solid-lumber forms.

Plywood packing cases, framed with nailed lumber edge strips, have great bracing strength, as well as excellent enclosure and protective features, and are light in weight. They are being used extensively for the shipment of radio cabinets, refrigerators, furniture, dry

goods, hardware, and many other products that require a sturdy but completely enveloping package.

The possibilities of bent and curved plywood for various industrial purposes have scarcely been explored as yet. Plywood sheets may be bent either in the process of glue assembly or between heated rolls after the glue has set. A midget radio case is shown in Fig. 7, in which flexible plywood has been bent after gluing, conforming to the contour of the flat plywood front.

In the structural field many architects and engineers are frank enough to predict that the inherent weakness of solid timbers and planks may be overcome by plywood processes yet to be developed.

Patterns for iron and steel foundry work frequently have large flat areas or webs where the shrink and swell of solid wood is exceedingly troublesome. In other instances the tendency to split or other weaknesses render solid wood unsuited to extensions or projections on patterns. Metal patterns are frequently too heavy, and combination wood and metal patterns have their serious limitations. Plywood offers a greatly improved wood material to the pattern maker, light in weight and free from solid-wood handicaps. It can be glued up, the same as solid wood, in any number of plies, with entire freedom from the unbalanced internal stresses of solid wood, and combined with curved or bent plywood in a range of simple or complex shapes that were never possible before this material had been developed for such purposes.

An interesting plywood adaptation has been developed in Europe. A special cutting process permits the making of veneer approximately $^1/_{100}$ in. thick. When three sheets are glued together in conventional 3-ply construction, the result is a plywood sheet $^1/_{32}$ in. in thickness, resembling cardboard, but tougher and having a wood grain. Like cardboard it can be bent, cut, stamped, formed, curved, and glued into cigarette and cigar cases, cosmetic receptacles, pill boxes, and other small containers where exterior appearance and toughness are important. The possibilities, as yet undeveloped in this country, are alluring.

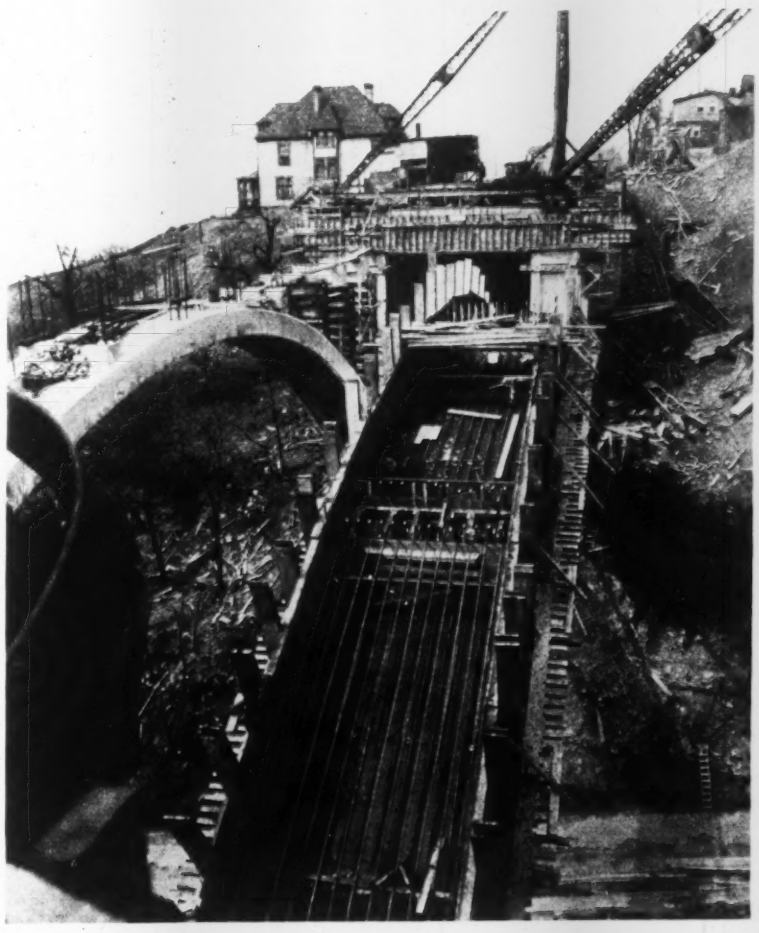

FIG. 6 FIVE-PLY DOUGLAS FIR PLYWOOD USED AS CONCRETE FORMS ON BRIDGE ARCHES AT BEN AVON (PA.) MEMORIAL BRIDGE

(The use of plywood results in better curves, smoother surfaces, and substantial erection economy. Courtesy Harbor Plywood Corporation.)

USEFUL PLYWOOD COMBINATIONS

While plywood is stronger than solid wood, additional face layers of metal will increase its strength, provided the extra weight is not objectionable. The combination of plywood and sheet metal is called "Plymetl" and is made by gluing thin stretcher-leveled sheets of metal such as steel, stainless steel, aluminum, monel, etc., to one or two faces of a stiff plywood panel. The application of metal faces to plywood may increase its stiffness up to ten times the normal (considering total thicknesses up to $^3/_8$ in.). Metal-faced plywood has a surface which takes duco and lacquer finishes. The metal face affords protection against weathering and impact, increases the fire resistance of the plywood, and gives it a hard, impervious surface.

"Plymetl" opens an even wider field for plywood. It can be used for the sides and roofs of buses, commercial-truck bodies, side panels of street cars, backgrounds of store-front signs, ship bulkheads, etc.

Closely allied with the metal-clad plywood just described is that surfaced with sheets of "Bakelite," "Formica," or "Micarta." This material finds wide use for table tops and lunch counters. Two examples are shown in Fig. 8, in both instances edged with the same surface material. Where light and pastel colors are desired various celluloid or phenolic compounds are similarly utilized.

Plywood for acoustical and insulating purposes can be advantageously made by gluing together face veneers, for appearance purposes, with dense or porous fiber boards, for sound or heat regulation, as shown in Fig. 9. This combination is especially applicable to radio cabinets and telephone booths on the sound-deadening side and for office partitions and refrigerator insulation in the temperature-control field.

A recent development, closely akin to plywood, is "Flexwood," in which very thin sheets of attractive veneer are processed to increase their flexibility, and mounted on cloth or a tough, thin paper like kraft. The result is a product similar to wall paper, preserving the natural beauty of the wood, susceptible to any type of wood finish, and yet easily applied to flat or curved

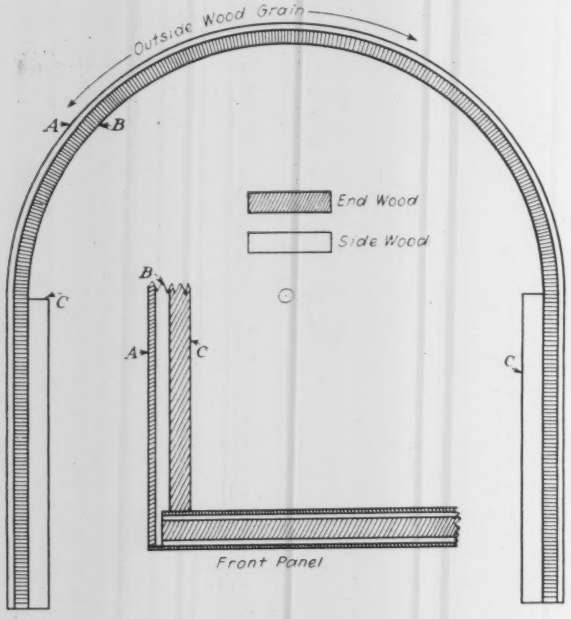

FIG. 7 PLYWOOD DESIGN FOR MIDGET RADIO CASE

A—Outside veneer strip, bent with the grain.
B—Inside veneer, cross-grained to above and very flexible.
C—Supporting wood block to keep plywood side from bending.

shapes of plaster, masonry, or metal. It affords a real wood that may be used for a wide range of artistic effects on walls and ceilings, as well as in many industrial products.

THE DURABILITY OF WOOD

Critics of wood products and promoters of wood substitutes have been quite inclined to emphasize what they term "the limitations of wood," such as its inflammability, its tendency to decay, and its susceptibility to attack by insects and other bacterial fungi.

Extensive research is in process at the present time to overcome these limitations of wood (solid and plywood), and a number of treatments are now sufficiently developed to give assurance of their practicability. It may safely be said, therefore, that wood products are rapidly reaching a point where their durability is much greater than that of normal wood, and where they are definitely superior to substitute materials.

WOOD SUBSTITUTES

Many wood and plywood substitutes have been developed within the last few years and in certain instances they have survived, not because of inherent superiority, but usually because of better research methods and a more skilful merchandising approach.

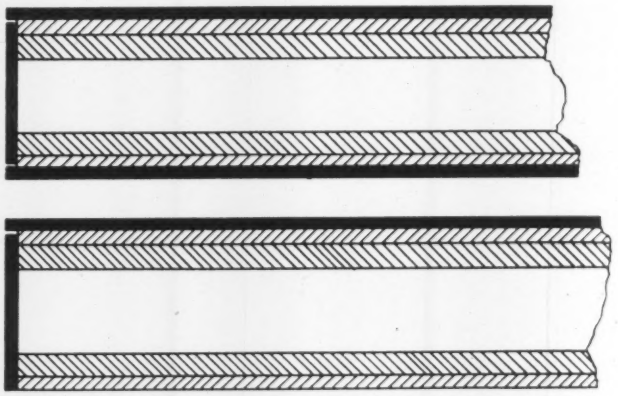

FIG. 8 MICARTA RESTAURANT TABLE TOPS

(Showing at the top a double surfaced and edged micarta top and at the bottom a single surfaced type of the same material. 5-ply lumber core used as a base in both instances. Courtesy Westinghouse Manufacturing Company.)

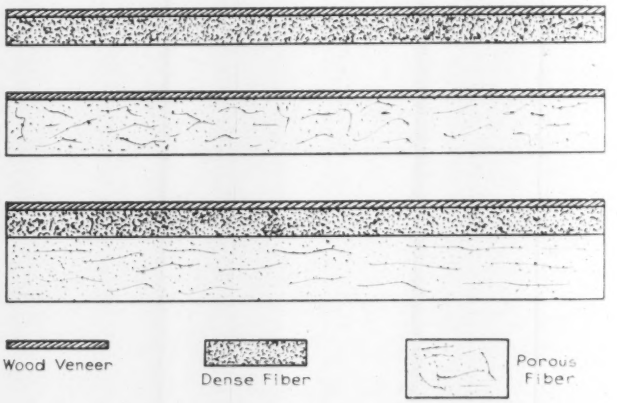

FIG. 9 VENEER AND FIBER BOARDS PLIED TOGETHER

(*Upper*, where strength and edge molding is required. *Center*, for super insulation where strength is not demanded. *Lower*, for strength and insulation of heat or sound.)

The advocates of wood and wood products, among which plywood may be numbered, have not been as aggressive, but it is already evident that the tide is turning and that the many excellent qualities of wood are receiving better recognition. Research in woodworking industries is expanding in volume and the results are increasingly apparent.

PLYWOOD COSTS

Plywood costs have many and diverse elements,

(*Continued on page 666*)

PUBLIC WORKS AND RECOVERY

Presenting Ways of Damping Swings in the Business Cycle

By DAVID CUSHMAN COYLE[1]

THE theory of "timed" public works, which was in its infancy a year ago, has been maturing fast under the stress of the last six months. A year ago, all that was known about it was that public works ought to increase in volume as private building decreased with the onset of depression; and with the return of good times, public works should be reduced accordingly. The problem is by no means as simple as this. The main points of the theory, in its present tentative stage of development, may be briefly summarized.

BUYING POWER NEEDED FOR RECOVERY

Recovery from depression can occur only by the diversion of large sums of money into the hands of workers who will use it to buy the products of industry. Normally, this result has come about through a revival of investment, leading to renewed commercial building, which gives employment to workmen and provides them with buying power. It can also occur by war, in which case money is paid to workmen for making munitions. A large program of public works would have the same effect on buying power. This last method is by far the best, because it does not produce any bad after-effects. Heavy investment, in the present state of development, leads necessarily to over-equipment and paralysis, as we have just learned by experience. War, in the end, ruins all sides. Public works and services act only to further civilization.

PUBLIC WORK AND BUSINESS STABILITY

Public work, in order to be effective as a factor in stabilizing business, must be clearly distinguished from investment intended to pay cash dividends. A commercial investment, such as a factory or an office building, requires a money income from the purchasing power of the community, to meet its capital charges. If the community is already supplied with this type of equipment, then all similar factories and office buildings are rendered partly idle, and their capital value vanishes in bankruptcy and default. That is what has been happening. Similarly, in case the country is already suffering from excessive competition among farmers, a public work such as a reclamation project, which increases the area of farm land, will add to that competition and make it harder for all the producers of similar farm products to meet their mortgages. This is true in some degree of all "self liquidating" public works. Even a toll bridge, though it may not be in competition with other bridges or tunnels, will extract dollars from the passing motorist and reduce his ability to buy gasoline or a new suit of clothes. The essential feature about all such projects is that they add to the "capital structure," that is, the mass of debt which looks for its interest payments to our old friend, the ultimate consumer. If that mass gets to be more than he can carry, it crashes and is destroyed by the natural but painful process of default. Productive or self-liquidating public works are an added burden on the pocketbook of the consumer; and if a crash comes, they help to make it more severe.

On the other hand, a free bridge need not take the dollars of the man on whose dollars business depends for a living. The Federal Government, unlike any city or private corporation, does not have to pay its debts out of taxes on consumers. Federal debts are therefore not necessarily a part of the load which business has to carry; and they do not necessarily contribute to the collapse that always occurs when the total of private and municipal investments gets too large.

MUST NOT COMPETE WITH BUSINESS FOR CONSUMER'S DOLLAR

It is evident, therefore, that public work, to be effective as a stabilizing factor, must not only be of a type which does not compete with business for the consumer's dollar; it must also be financed by a body, such as the Federal or state government, which has the power to get money from other sources than the consumer. The only sound way to pay for public works is out of money that would otherwise be used, not to buy goods and services, but to overequip private industry and commerce. If capital money is diverted to non-commercial equipment, such as public and semi-public works for the production of free services, the effect is cumulative. It keeps down the overhead of business while adding to its market. Capital money, in our present system, can most easily be reached by the upper brackets of the income and inheritance taxes. Therefore, if cities are to continue to do most of the public work, the funds should be furnished by the state or nation. If this principle is not observed, the public work which gives business a market with one hand, takes away that market with the other. That is "pulling the bootstraps;" and that is why local relief has not helped the return of prosperity.

HOW TO FINANCE PUBLIC WORKS

The method of temporary financing is also a vital element in the soundness of a public-works program. In depression, when public expenditures need to be

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increased to a large extent, tax returns are of course at a low point, and the money has to be borrowed in one way or another. In the last three years cities have borrowed large sums by selling bonds to the public. The result has been to help depress the bond market, thus ruining many banks, and deflating the purchasing power of their depositors. Later on, if prosperity returns, most of the bonds will be paid, and the holders, finding themselves with lump sums in their hands, will invest them in the securities markets. This will inflate the boom and help to bring on the next crash. This too is an exercise in bootstraps. It is a rhythmic cycle of deflation and inflation, in phase with the business cycle, and aggravating the effect of the latter. The temporary financing does as much harm as the works do good.

PUBLIC WORKS AND THE BUSINESS CYCLE

In order to be sound, the financing must be in opposite phase from the business cycle; therefore it must be done under Federal authority. The bonds ought to be sold not to the public but to the Federal Reserve, which can expand credit and currency to pay for them. Then when they are paid off in good times, the credit and currency are contracted again. This is also a rhythmic inflation and deflation, but out of phase with the business cycle; it will therefore reduce the amplitude of the fluctuation of business. If the financing is done in this way the effect will be cumulative instead of zero or worse. This principle was not understood three years ago; therefore the country approved the policy of throwing the burden of relief on the cities, with the results that we see.

The problem of public works, however, has a much larger significance than is indicated by its relation to the business cycle. This depression differs radically from any that has occurred before in the fact that it is aggravated by the sudden growth of technological unemployment on an overwhelming scale. The "continuous process," in particular, is about to affect the economic system in ways that will make the business cycle of secondary importance. It is a fact that will become increasingly evident, that the manufacture of goods and services by the use of raw materials and mechanical power is no longer in any large degree a function of human labor. An increasingly large majority of our people are permanently out of a job so far as machine industry is concerned. This fact is either appalling or the best news that ever came to the human race, according as we can or cannot adjust our economic structure to it.

PUBLIC WORKS OFFER OPPORTUNITIES FOR JOBS THAT MACHINES CANNOT PERFORM

Failure to adjust to the improvement of technology means permanent unemployment on such a scale as to make the collapse of our whole system inevitable. Adjustment requires a rapid change in the balance of industry. For the past dozen years this country has been spending an increasing proportion of its income on services rather than goods. This tendency needs to be largely accelerated. It now becomes evident that if employment is to be found for our people, not only must the expenditure for goods be considerably increased, but the expenditure for services must be increased to a vastly greater degree. For in a rough way it may be said that goods are mostly made by machines and services are mostly performed by people. And it is finding jobs for people that is the major problem.

It is here that public work has an important part to play, especially during the period of adjustment. A park, a campaign against the corn borer or the hookworm, a modern system for treating criminals and defectives, all require a large amount of work that cannot be done by machines, and that is not limited in amount by the limits of available power and raw materials. A very large increase in public spending is the only immediately practical way to direct the market into those lines that will furnish jobs for men as well as for machines.

If, as may soon be the case, all our available power and raw materials can be utilized by one quarter of our available labor; then it follows that the rest of the labor must be employed in jobs that have no significant dependence on power and raw materials. Otherwise there will be no market for the products of the few who are employed. And that means services of all kinds from public opera to national parks, not merely as a temporary device for helping a depression, but as a long-time policy to support the market for industrial products. This may sound terrifying, but it means merely that the economic situation in this country has reached a point where we must either live like the richest nation that ever existed, or lie down and die.

DIFFERENCES OF OPINION ON PUBLIC WORKS

Public works, then, have come to be a matter of critical importance; and the differences of opinion and understanding among engineers, public officials, and laymen in general are taking the form of a vital conflict between forces leading to recovery and policies that lead to final collapse. Recovery can only occur by some action that involves very heavy expenditures of money by somebody, through which millions of men are employed and enabled to buy the products of industry. This expenditure must not be an investment in projects that will depend on buying power to pay for them, because we already have too much industrial equipment as it is. Self-liquidating projects are sound only on the understanding that when the time comes to liquidate them we will change our policy and forget it. The money to pay for public works must come out of capital taxes such as the "upper brackets," or else the whole thing is an exercise in bootstraps. The temporary financing must be so arranged that the fluctuation of credit or currency, necessarily involved, is out of phase with the business cycle. Finally, the expansion of public and semi-public services will have to be continued for a long time and on a large scale, even after recovery takes place, in order to employ the men permanently displaced by technological improvements.

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SILK WORMS ON MULBERRY LEAVES

SILK:

An Attempt at Price Control That Failed

ATTEMPTS to control the silk market of the world are very old indeed. For centuries, China, which was once the sole producer or the sole exporter of this valuable luxury, took steps to prevent other countries from raising it. The exportation of silk worms and larvae was prohibited under penalty of death. Like many other attempts to monopolize production, this one failed. According to the story, two Byzantine monks brought out of China either eggs or larvae hidden inside of bamboo staves, and the production monopoly was broken.

POST-WAR EFFORTS BY THE JAPANESE GOVERNMENT TO CONTROL THE PRICE OF SILK

The more recent history of silk control has primarily to do with the steps taken by the Japanese government or by banks controlled by the government or operating in accordance with its policies. During the war silk prices were high, but the close of hostilities eventually produced the same slump in the silk business that has affected so severely many other industries. It was then that the Japanese government organized the first "taishan" or price-control syndicate. Comparatively little is known about the details of its operation today, except that it was reasonably successful both in stopping the price toboggan on the silk market and, even, in making a small amount of money, about $1,500,000, for the government and some members of the syndicate. Direct profits from the operation, however, were not a deciding factor, and as a matter of fact a share of the money made by the government was employed for the good of the industry by way of research and the support of various experimental projects in the growing and treatment of silk.

About five years later, that is, somewhere around 1925 or 1926, a second period of depression struck the silk industry and the government again resorted to the formation of a taishan. Once again the results were very successful. Prices of silk went up and a direct profit of some $6,000,000 was made on the operation, a

Ewing Galloway, N. Y.

REELING THE SILK FROM THE COCOON—AN OPERATION THAT IS LARGELY RESPONSIBLE FOR KEEPING THE SILK INDUSTRY IN JAPAN

sum that was quite substantial considering the comparatively limited volume of business in silk.

To understand why the third attempt of a similar kind, that is, the taishan organized in the early part of 1930 and more or less continuing (in a greatly modified form, however) to the present time, has not been equally successful, it is necessary to understand the background of the silk industry. Approximately 80 per cent of the silk imported into the United States comes from Japan and it is the purchases by this country that control the world prices of silk.

ELEMENTS OF THE SILK INDUSTRY IN JAPAN

The Japanese farmer depends primarily on two crops—rice being the food crop and silk the money crop. Even with his primitive standard of living the Japanese farmer must have cash to buy agricultural implements and essential commodities that he does not produce, and to pay taxes. The farmer raises silk cocoons and sells them at local auctions to the filatures which convert the cocoons into yarn. It is the operation of the filatures that prevents the development of silk manufacture in the United States. While it is possible to raise in this country as fine silk cocoons as anywhere in the world and while we have the soil and climate necessary for it, the conversion of the cocoon into yarn is a skilled, exceedingly tedious, hand job which cannot be performed at the wages prevailing in this country and which is entirely unsuited to the temperaments of our workers. In Japan the filatures have ample supplies of labor willing to work for low wages and possessing generations of experience in this particular line of work. Even there, however, the majority of the filatures are of local importance only and employ comparatively small numbers of workers. This is only natural in a handicraft industry where close supervision of the worker is one of the most essential elements of success.

The filatures as a rule sell their product to "toynas," or silk brokers, who occupy approximately the same position as do commission merchants in many branches of American industry. On one hand, the toynas constitute the connecting link between the locally scattered filatures and the great exporting houses; on the other hand, they assist in financing the operations of the filatures, who, in the majority of cases, if not always, must pay cash for the cocoons bought from the farmers. The organization is, of course, not absolutely rigid. Some toynas own filatures. In other cases, the exporting houses, such, for example, as the great Mitsubishi interests, have brokerage organizations of their own, and act not only as toynas but also buy from other toynas. In general, however, the four elements are fairly well maintained throughout the industry that is, farmer, filature, toyna, and exporting house.

THE 1929 SLUMP IN THE SILK INDUSTRY

The most recent slump in the silk industry began sometime in 1929, several months before the stock-market crash of October of that year. Talk of a new taishan commenced at once, but no actual measures were taken until after the events of October and November showed that the silk industry was facing not a temporary setback but a period of apparently prolonged disturbance. When a program for maintaining the price of silk was finally developed it was split into two lines of operation. On one hand, the government bought some silk on the market at prices of the order of 1250 yen per picul (roughly 135 lb net); on the other hand, it came to the support of the filatures who found themselves deprived of access to financing usually provided by the toynas, and made advances to them to the extent of some 750 yen per picul, on condition, however, that the marketing of the product should be restricted.

THE JAPANESE GOVERNMENT OVER-STOCKED WITH SILK

Under this arrangement the government found itself in the spring of 1930 with approximately 120,000 bales[1] on its hands. Of these about one half were suitable for exportation to the American market, which, because of the high cost of labor, can take only the best grades. Twenty thousand bales were of a grade not suitable for the American market but were acceptable to the European markets. The rest were fit for local use only. The world's hunger for silk failed to develop in the years following the spring of 1930, while the efforts of

[1] A bale is substantially a picul, with this difference, however, that a picul represents a weight, while a bale is a unit of sales. Therefore, where reference to price is made, the common procedure is to quote by the picul, while sales volumes are measured in bales.

the Japanese government to restrict silk production at the source, that is, by the farmers, were neither wholehearted nor successful. Provincial magistrates were instructed from Tokyo to see that the crops were restricted, but they neither tried very hard to accomplish this purpose nor indeed was there any way for them to do so without establishing an extensive and expensive organization and without creating a strong antagonism to any government that might try to put through a real restriction program. Silk is practically the only money crop of the Japanese farmer, who lives so close to what might be called the economic ragged edge that it would be difficult for him to submit to further restrictions. Incidentally, nearly 1,500,000 Japanese are dependent on the silk industry for their livelihood, and the political situation of the country is not of a kind to permit antagonizing such a group for what, after all, can be described as only an economically nebulous purpose.

The result, therefore, was that while the government was holding some 120,000 bales (less about 12,000 which were disposed of in various ways by the beginning of 1930), there could be no sound movement toward a higher price level. It constituted too ominous a thunder cloud hanging over the silk market to permit faith in even such a modicum of sunshine as might pass down through it from time to time. The prices slid from about the $4 level to as low as $1.50, and at the same time the economic condition of the farmer, as well as of the government, was becoming more and more untenable.

THE ASAHI-GERLI CONTRACT

It was under these conditions that the famous Asahi-Gerli contract was entered into with the Japanese government. The text of the contract has never been published, but enough of it has become known to draw a general picture, devoid, however, of reliable detail. The Asahi Company is a large Japanese brokerage and exporting organization closely allied with the government, particularly the party which was at that time headed by Inouye, the premier since assassinated. The Gerli Company is a large factor in the silk trade in the United States and has powerful banking connections. The contract required financing to the extent of some $17,000,000 and it was no easy matter to raise such an amount in these times. It would appear that one of the conditions of the Japanese government-Asahi-Gerli contract was that the world price of silk should not fall below the level prevailing at the time when the contract was signed, the Asahi-Gerli group undertaking to take the 107,000 bales of silk, then available, off the hands of the Japanese government and to merchandise it in such a manner as not to break the price of the commodity on the world market.

Exactly why the scheme of price stabilization embodied in the Asahi-Gerli contract failed to bring about the expected results is not quite clear. It would seem, however, that in addition to certain other factors involved, the Gerli contract placed a certain amount of control over the silk market into the hands of one strong group in the United States and more or less left out in the cold other groups with powerful connections both in this country and in the Far East. The Asahi-Gerli scheme contained on the face of it elements of vulnerability. The combination did not control the world market in silk to the extent of really being capable of keeping out those who would want to secure their silk supplies elsewhere, providing they had the money and connections to find the silk and pay for it. Finding the silk was not difficult and the money to pay for it was available. A powerful bear campaign therefore started and prices rapidly crashed through the artificial bottom established by the Asahi-Gerli contract. This, together with the distress of the silk-growing farmers in Japan, as well as the recent shift in Japanese politics with its clear attitude of unfriendliness to the great moneyed interests, brought about the cancelation of the Gerli contract by the Japanese government. Neither the basis of cancelation nor the provisions of the contract that would permit it, have ever been announced, but no loud protest has been launched by the Gerli interests. This might indicate that with prices as they are, those at the American end of the agreement may not have been sorry at being relieved of the somewhat

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SILK WORMS ON FEEDING TRAYS—THE COCOONS ARE SPUN ON THE RICE STRAW IN THE UPPER TRAYS

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AN IMPORTANT FACTOR IN THE SILK INDUSTRY—TESTING RAW SILK IN A MODERN SILK MILL

doubtful pleasure of trying to decelerate the downward rush of silk prices.

WHAT HAS BEEN LEARNED ABOUT STABILIZATION OF SILK PRICES

Viewing the whole history of the efforts to stabilize the prices of silk in the last ten years, the following factors stand out. In the first place, unlike what happened in the case of rubber, the Japanese efforts toward stabilization have not tended to produce new sources of supply. This was, of course, because of the peculiar conditions of the industry, and was a fortunate factor in the situation. Two previousefforts at price stabilization have been successful and apparently have been carried out in a skilful and temperate manner, assisting the Japanese, but not creating any open antagonism in the United States, the country providing the biggest market for Japanese silk.

On the other hand, however, it must be very clearly remembered that the depressions of 1920 and 1925 were of short duration and were followed by a revival of business in the United States. The Japanese therefore speculated, as one might say, on a rise of prices in a bull market and were fortunate enough to see prices rise, not as a result of their own efforts, but through the working of the mighty forces of the economic mechanism of the world. They hitched their wagon to a star while the star was going up, but when they tried to do the same thing with the star going down, they crashed, showing thereby that a little boom in a period of big booms works well, but that it is a different proposition to try to work a boom in a time of an honest-to-goodness slump.

Keystone-Underwood

IN THE SILK MILL—WARPING

It should be remembered that in so far as the Japanese government was concerned it was interested not only in the prices of silk, but in the welfare of that substantial group of its citizens who directly or indirectly depended on the silk industry for their living. The huge invest-

(Continued on page 64)

Courtesy Extension Division, Rutgers University

LARGE GROUP INSTRUCTED BY LECTURE-CONFERENCE METHOD

What's Ahead in FOREMAN TRAINING?

Status of Foremanship—Development and Varieties of Foreman Training—Outlook for the Future

By EDWARD S. COWDRICK[1]

AMID the keen competition, scrutiny of costs, and pressure for efficiency which are certain to characterize the years of recovery from the current depression, a rôle of steadily increasing importance in American industry will be played by the foreman. Improvement of supervision, for more than a decade one of the prominent aims of production management, may be expected to be carried forward further and faster than ever before.

Managers have come to realize that however expert the production organization, its efforts depend for success upon the intelligent cooperation of the first-line supervisor who interprets policies and transmits instructions to the men in the shop. If the line organization may be likened to a complicated and powerful machine, the foreman is the cutting tool by which that machine shapes the finished product. If the tool is blunt or defective, the machine will turn out scrap, however perfect may be the motors and pinions and gears.

For the improvement of foremanship two methods are at hand: selection and training. In selection much progress already has been made. In plants with forward-looking management, the foreman is no longer merely a super-workman elevated through favoritism or according to such casual factors as seniority or manual skill or attractive personality. Some semblance of scientific determination of the qualities requisite for promotion to supervisory rank and some attempt to discover the men who have those qualities are to be found in many organizations. Further development in this field is to be expected.

In foreman training also the progress made is impressive, and the outlook holds cause for encouragement. Before attempting to chart a course for the future, however, it will be worth while to look at the present situation in order to find out if possible just where we are and how we got here. During the year 1931 the author made an extensive survey of foreman training in American industry, in the course of which he secured information from a large number of employers as well as from educational and other institutions and from individual authorities. The factual results, which

[1] New York, N. Y.

Courtesy Federal Board for Vocational Education

CONFERENCE GROUP AT CONCLUSION OF DISCUSSION. NOTE SUMMARY ON BLACKBOARD AT END OF ROOM

were determined as a consequence of this survey have been reported elsewhere.[2]

From the study made in 1931, and from complementary information collected since then, a few definite observations are possible.

STATUS OF FOREMANSHIP

The raw material for foreman training is the foreman himself. Here at the very outset we find a situation of some confusion, since this raw material comes from various sources and is far from uniform in quality. In American industry as a whole, foremanship may in fact be said to be in a transition stage. Until comparatively recent years the duties of the foreman were general and not closely defined. Usually a promoted workman without technical training, he was held responsible for results in his department, and often was left pretty much to himself in determining the methods by which these results should be obtained.

The inefficiency and lost motion involved in the old type of foremanship early attracted the attention of Frederick W. Taylor, and in a paper on "Shop Management," presented before The American Society of Mechanical Engineers in 1903, he analyzed the foreman's duties and attempted to bring order out of the confusion which he had found in the average workshop. Taylor found that the foreman was burdened with a mass of uncoordinated tasks calling for qualifications that ranged all the way from expert workmanship to executive ability. Partly as a means of overcoming this situation, he advanced his principle of functional control. By a process of analysis he defined eight functions in the productive process, with some or all of which the overburdened foreman was struggling. He then selected the duties which he thought really belonged to the foreman, and transferred other functions to different officials.

This analysis and the other principles of scientific management with which it was associated have exerted profound effects upon the development of American production methods. As to foremanship, however, Taylor's principle of functional control has not been fully adopted. In the typical factory the foreman's duties represent a compromise between Taylor's theories and the traditional conception of an independent boss with broad but ill-defined responsibilities.

Similar lack of uniformity is found in the personal qualifications and background of foremen. In spite of a distinct tendency toward scientific selection and the promotion of technically trained men to supervisory positions, it is probable that even yet the majority of foremen employed in American productive industry have been promoted from the ranks of manual workers with comparatively little regard for qualifications beyond those that were developed in the shop. Often in a single plant similar supervisory positions are held by young engineering graduates and by old-time workmen who have come up through the ranks, and whose knowledge of technical processes has been gained only through experience.

Through the natural processes of turnover and the increasing adoption of modern methods of selection, it is likely that within the next few years the relative numbers of technically trained foremen will be greatly enlarged. This tendency is receiving powerful stimulus from the increased complexity of machine production and the more exacting requirements of supervision in the modern factory.

DEVELOPMENT OF FOREMAN TRAINING

Recognition of the shortcomings of nineteenth-century foremanship as applied to twentieth-century industry was largely responsible for the initiation of

[2] Particularly in a paper, "The Training of Foremen in Modern Management Methods," prepared for the International Management Congress held at Amsterdam in July, 1932.

FACTORY SUPERVISORS LISTENING TO A LECTURE WHICH IS TO BE FOLLOWED BY DISCUSSION

Courtesy Extension Division, Rutgers University

foreman training. While it is true that in isolated cases training was conducted at considerably earlier periods (the author's survey disclosed one company which as early as 1885 began educational work closely resembling present-day foreman training), systematic education of supervisors is mainly a product of the period which began about the time the United States entered the World War. From about 1917 until the end of the post-war boom its extension was extraordinarily rapid.

This development was due largely to conditions which confronted the industries of the country during the war period. With man-power depleted by the call to army service, and with new demands for unaccustomed products in unprecedented quantities, factories were required to speed up production and often to undertake intricate new processes. New employees, some of them hastily recruited from farms and homes, had to be trained for factory work, while many manual workers were suddenly elevated into supervisory positions. It soon became evident that some method of organized training was badly needed, not only in order to instruct the raw foremen in the rudiments of supervisory tasks, but also to adjust older supervisors to the new tempo of production.

At the same time modern methods of personnel administration were being developed, and in many companies it was found that these methods were badly interpreted and sometimes actually opposed by the officials having immediate supervision over the workers. In this field also, training of foremen was urgently needed.

To meet these demands numerous experiments in foreman training were undertaken by employing corporations, by commercial organizations, and by public or semi-public agencies, including the Federal Board for Vocational Education.

The depression of 1920–1922 brought sharp curtailments of foreman-training activities, but they were resumed on an enlarged scale during the subsequent period of industrial activity which ended in 1929. The present depression has seen the temporary abandonment of some training programs and the curtailment of others, partly on account of financial stringency and partly because, with reduced labor forces, there are fewer foremen and potential foremen to be trained than there were during the more active period. By this time, however, the value of foreman training has become so widely recognized that there is little talk of its permanent displacement in enlightened companies. There is every indication that with business recovery it will take a more prominent place than before in the program of industrial education.

VARIETIES OF FOREMAN TRAINING

In the development which has just been hastily sketched, foreman training took a variety of forms, some of them differing so fundamentally that they almost defy comparison or classification. Foreman training as it is being conducted today shows striking variations in pedagogical theories, in subject-matter, in types of courses, and in the agencies by which it is operated.

Perhaps the most fundamental of these differences, and the one which accounts wholly or in part for most of the others, is that which relates to theories and purposes.[3] Throughout the development of foreman training, employers and their advisers have been motivated by two distinct aims:

1 To impart knowledge, culture, or inspiration
2 To train foremen in straight thinking and in the formulation and expression of sound judgments.

This disagreement as to purposes goes to the very heart of foreman-training philosophy. The employer

[3] The classifications here used are from an unpublished report "Foreman Training in the United States," by Edward S. Cowdrick.

who believes that the primary need is to furnish information to men whose education has in most cases been neglected, will naturally proceed by methods different from those adopted by another employer who thinks his foremen already know enough about their jobs, and that their most urgent need is to learn how to think out their own problems by logical processes. It is true that this distinction is not always definite and clear-cut; most foremen courses in fact seek to attain both purposes—to furnish some information and to provide some training in clearness of thought and expression. Nevertheless the distinction is real and fundamental, and by keeping it in mind we shall be able to understand many vagaries of foreman training which otherwise might be puzzling.

As to subject-matter, foreman-training courses may be conveniently classified as follows:

1 Technical
2 Management
3 Inspirational, informative, and cultural.

Types of courses are so numerous that analysis is difficult. The most common of them are:

1 Correspondence courses
2 Classroom courses
3 Lecture courses
4 Lecture-text courses
5 Lecture-conference courses
6 Text-conference courses
7 Pure or "straight" conferences.

The nature of the courses listed is sufficiently indicated by the names that have been applied to them. Each type has been extensively tried out in actual practice, and each has its points of merit. Classroom courses have been adopted mainly when the subject-matter to be taught was of the technical variety. Lecture courses in unmodified form were largely used in the early days of the foreman-training movement, but have since fallen into some degree of disrepute. Pure conferences (the method sponsored by the Federal Board for Vocational Education) have been popular and successful, especially when the main purpose was to train foremen in straight thinking and in solving their own problems. The weak point in this method, if it has one, lies in the fact that it offers inadequate facilities for introducing fresh knowledge or new ideas not already possessed by some or all the members of a discussion group. Partly to overcome this disadvantage, the lecture-conference method has been widely adopted, particularly by university extension divisions. Choice between types of courses naturally will depend largely upon the purposes of the employer and the conditions within his company or plant.

Of the agencies for foreman training, perhaps the most important is the educational department of the employing company. Other agencies, include:

1 Commercial organizations (including those selling correspondence courses)
2 Extension divisions of colleges and universities
3 Trade associations
4 The Y.M.C.A.
5 Foremen's clubs
6 Local boards of education
7 State and federal boards for vocational education.

An observer of the diverse methods and theories by which foreman training is being conducted is impressed with the lack of cooperation among educators of foremen and by their failure in many cases even to understand each other's purposes and points of view. In many cases advocates of a particular method seemingly have gone ahead in their own way without troubling themselves much to find out how their courses differ from others, and whether there is anything to be learned from their competitors. This lack of cooperation and understanding has hampered the growth and the full effectiveness of foreman training in American industry.

OUTLOOK FOR THE FUTURE

The survival of foreman training as an essential part of the industrial-education program probably is assured. Already it has made a place for itself from which it is unlikely to be permanently dislodged. In order that it may perform a function of maximum usefulness, however, educators and industrial managers should join forces to bring about certain needed improvements in policies and practices affecting foremanship.

1 There should be a greater general recognition of the foreman's responsibility in the production organization, of the importance of his duties, and of the need for a still further toning up of the quality of supervision. Industrial methods will go through sweeping changes in the years immediately following the business depression. These changes will be not merely technical; they will extend throughout the field of management. One thing is certain: no industrial developments now in sight will take away anything from the responsibility of the foreman for effective production in the shop. On the contrary, these responsibilities are likely to increase, while at the same time the foreman will need a continually greater stock of general and specific knowledge. For the requirements of 1936 or 1940 the foreman of 1929, unless in the meantime he has broadened his knowledge and kept in step with improved processes, will be as unsuited as the nineteenth-century doctor in a modern hospital.

2 In part, the need for better foremanship should be, and doubtless will be, met through the further adoption of scientific methods of selection. When a workman is placed in his first supervisory position, he has taken the first—and perhaps the longest and hardest—step in the march of advancement toward executive responsibility. Selection of the man who is thus to join the ranks of management is not a matter to be undertaken lightly or casually. Perhaps production executives have no more important duty than that of picking the men who are to serve as their subordinates. The old practice of making a foreman out of a workman because he had long service or because he happened to be the best worker in the shop or because his personality appealed to the superintendent, is totally unsuited to the needs of present-day industry.

(Continued on page 646)

ENGINEERS' COUNCIL *for* PROFESSIONAL DEVELOPMENT

By C. F. HIRSHFELD[1]

MOST of us are so fully occupied with the activities of the present that we give little thought to those grandly proportioned movements that may be said to constitute the stream of life in which we are immersed. We snatch therefrom the daily necessities and pleasures and other satisfactions, to the extents that we are respectively capable of, and we find ourselves amply occupied. Few have time or even inclination to study the course that the stream has followed in reaching the place where they know it. Fewer are interested in attempting to determine in even an approximate fashion where it may be trending.

SOCIAL, POLITICAL, AND ECONOMIC PROBLEMS MUST BE STUDIED AS THE TRANSIENTLY EXISTING PRODUCTS OF A LONG SERIES OF CHANGES

It is becoming more and more evident that, just as contemporaneous organic life can be interpreted fully only on the bases furnished by a knowledge of time-consuming evolutionary processes, so must all our communal problems, i.e., social, political, and economic, etc., be studied as the transiently existing products of long series of changes. One may say that all things having to do with life must be viewed in perspective if they are to be even partially understood. And when so viewed, one realizes fully, not only the irresistible flow of the stream of life, but also the tremendously important effects on its future course exerted by events which at the time appeared of little vital significance.

When human life and human activity are thus studied in perspective, a very peculiar fact appears. Apparently without volition on the part of man, the stream of life gradually takes on certain new characteristics and continues to evolve and develop them until, almost suddenly, man realizes the existence of a new state of things. The majority accept with or without complaint but always without thought to significance. The few attempt to interpret and to predict therefrom the possible outcome, the effects upon the future course of the stream and upon the weal of humanity.

It seems hardly possible that these apparently spontaneous changes are entirely fortuitous. It appears more reasonable to assume them to be the products of mental evolution moving as starkly onward as does the better recognized and better understood organic evolution. That they are real is attested bountifully by the known history of the race; that they are continuing is shown by current events; that they will continue is a reasonably safe surmise. It is only necessary to consider the change in governmental form from that of a few centuries ago to the blatant democracy of the present; the gradual development of the idea of expending some of the wealth of the community for the care of the less fortunate; the very certain trend toward taxation on the basis of the degree of worldly success achieved; the tendency toward the expenditure of private wealth for social as against selfish purposes, to realize the diversity, the magnitude, and the seeming irresistibility of such movements. That they greatly modify the course of the stream of life is obvious. That they progress for quite a distance down this stream before they are generally recognized is equally obvious. Whether man can do anything about them is still largely an open question.

We do know that man can control organic evolution to a certain extent, in the sense that he can produce strains and breeds which better meet his temporary purposes than do the naturally available fruits of Nature's unmodified works. We do know that man is now giving serious thought to the application of similar principles to the "improvement" of the human race both physically and mentally. Given adequate definitions of what should be produced, a free hand in the selection of material, and power to eliminate undesirable products, man with his present knowledge could undoubtedly come fairly close to fulfilling the specification. We all recognize, however, that he begins to get on ground that is extremely dangerous when he attempts to go this far. The possibilities are there; but whether the results would be good or bad no man can say.

THERE EXISTS NO REASON WHY MAN SHOULD NOT STUDY THE PRINCIPLES LEADING TO THE MENTAL AND PHYSICAL IMPROVEMENT OF THE HUMAN RACE

When we come to the consideration of the control of the huge modifications of mass thought that have been classed above as probably of the nature of mental evolution, we find ourselves on what may be equally dangerous ground. These movements are so deeply rooted, so tremendously spacial and so significant that it is questionable whether man has sufficient knowledge to control them to beneficent ends if indeed he finds he possesses any power of control. This is, however, no reason why he should not study them most diligently, attempt to determine their trends and significance, and make a conscious effort to discover whether there is anything he can do to assist what appears at the time to be for good and to provide for such control as is possible over that which appears to be directed toward evil. It is only by such study that he can place himself in position to judge wisely whether he should or should not meddle.

We may now consider a specific case which is responsible for this article. Engineering is indeed very old, probably almost as old as the human race, since humanity as we know about it has been characterized by its ever-increasing ability to use Nature's forces for its own ends. But the past few decades have seen a most rapid and most significant change. The engineer and his works have almost suddenly become so predominantly controlling in our civilization that the present generation would have difficulty in forming a real picture of life as recent as that of its grandparents' youth. Our whole social structure, our very life now rests upon engineering.

When we look back we can see that we reached our present state by comparatively simple and obvious evolutionary steps, but that which has resulted we now realize somewhat suddenly

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is little short of revolutionary. We now find ourselves confronted with magnificently proportioned problems which have been long in the making but whose birth and growth were not only unnoticed but actually unsuspected. The "affairs of the world" were in the hands of men with the educations and trainings of past generations and to some extent of past centuries. These little suspected what the engineer was doing to the world that they knew. The engineer himself was satisfied to delve and to produce without giving much thought to other than the obvious and desired results of his labors. And now, here we are with a rebuilt world, new ways of doing things, new ways of living, even new ways of thinking, but handicapped by the fact that we have not advanced our front evenly. A huge salient has been produced by the engineer using new weapons; no one has thought it necessary similarly to advance all the other phases of life as necessary to produce a coordinated and consolidated advance.

To some of us it appears that we have now reached the point where the engineer must give conscious and serious thought to the concomitant results of his activities. We do not go so far as to believe that the engineer alone must or can set the world aright, or even that he alone possesses the power to solve those particular problems that his works have brought into being. We do, however, believe that he must now become self-conscious, social conscious, and world conscious. He must, so to speak, come out of his technological shell, understand the world, and be understood by the world. He must serve as the interpreter of his activities if he is to cooperate effectively with others in dealing with their results. In short, he must do his share in the handling of world affairs in which he and his works have become so greatly involved.

Those of us who see matters in this light realize that the engineer cannot jump suddenly from his drafting board or shop or office into the maelstrom of public life or even into the less strenuous activities in the wings. We realize that he must first prepare himself; that he must cultivate a broader, a more comprehensive view; that he must acquire the power of doing things of a non-technical type but by means of the same general thought processes as he now uses. If he is to serve in this broader way it must be through the widespread introduction and use of the scientific and engineering methods in the solution of problems of types to which such methods have not yet been generally applied.

It is thoughts of this character that lie back of the formation of the Engineers' Council for Professional Development. We would have the engineering profession studied much more comprehensively than it has been. We would have a very careful selection of raw material and an equally careful preparation of that material for its work in the world. We recognize that education is in reality a lifelong process and that its extension in years becomes more and more important as the field of activity is extended. Therefore, we would provide for such assistance and guidance as may prove possible and desirable after the completion of such formal studies as are generally becoming recognized as prerequisites for entry into the profession of engineering.

It is highly important that these ideals and ambitions be not misunderstood. We are attempting to provide means whereby the profession may be elevated, expanded, and improved along safe, proper, and wholesome lines. We are attempting, in a proper and dignified way, to turn away those not fitted for the study and practice of engineering before they become too deeply involved; both to save them the discouragements and heartbreaks that go with failure and to elevate the average of those bearing the label. But we are not attempting to exclude. We hope to do in a gentle and kindly fashion what the world will eventually do anyway in a harsh and disheartening way. We are attempting so to arrange matters that one who is naturally capable and desires to study engineering may do so with the greatest certainty that what is taught him will be worth while and of timely value. We are trying to bring to engineering education the thoughtful advice and cooperation of men who have been through the mill and who know what is needed; but we have no intention of dictating to such educators. We expect to be of real assistance to many ambitious souls by devising ways and means whereby they may be guided in study in their apprentice years, but we do not propose to fix courses of study which must be completed as a prerequisite for some sort of trophy, degree, or recognition.

A PROGRESSIVE PROGRAM

The initial program proposed by the Engineers' Council for Professional Development has been stated as follows:

"First, to develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members;

"Second, to formulate criteria for colleges of engineering, which will insure to their graduates a sound educational background for practising the engineering profession;

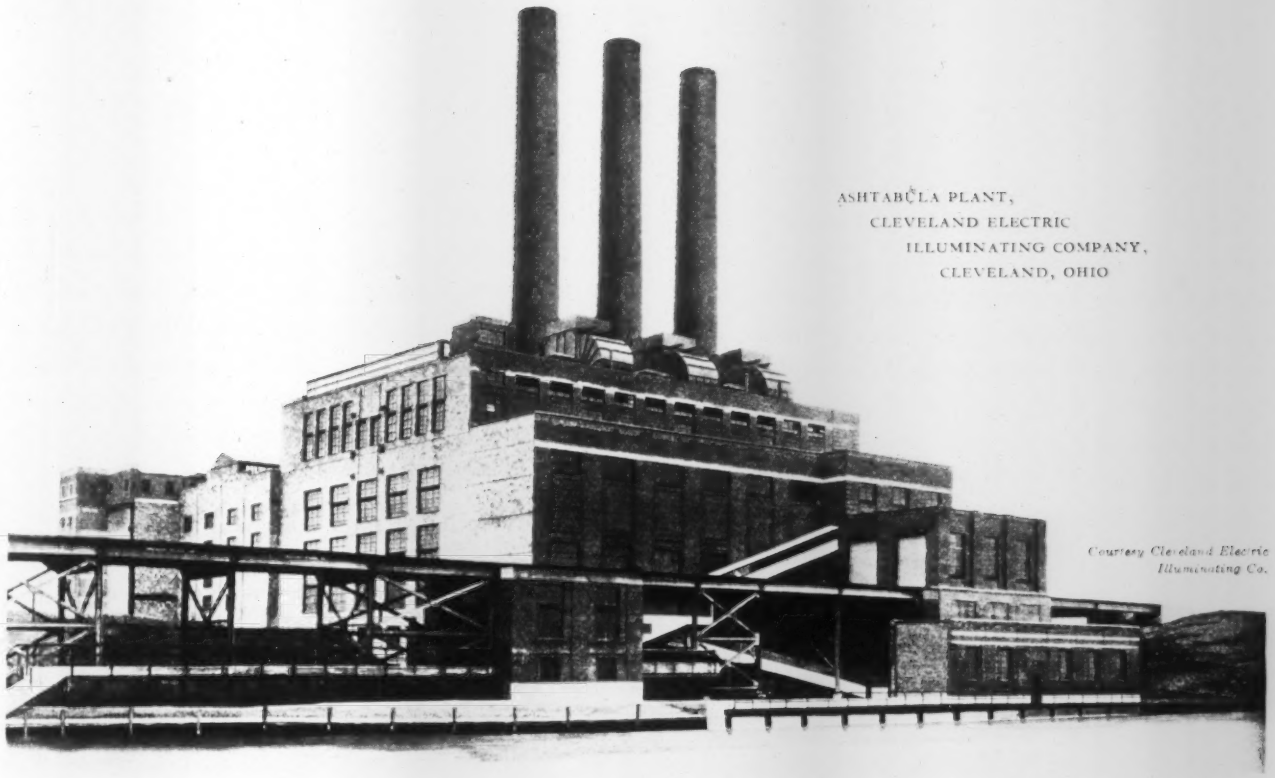
"Third, to develop a program for the further personal and professional development of young engineering graduates and a program for those without formal scholastic training;

"Fourth, to develop methods whereby those engineers who have met suitable standards may receive corresponding professional recognition."

This country has been built on the basis of offering opportunity to all in so far as that is humanly possible and in then permitting the individual to work out his own salvation. Those of us who have been active in the formation of the Engineers' Council for Professional Development have no desire to alter this situation. We are concerned in improvement of the opportunities offered and in assisting those who choose to avail themselves properly thereof.

Finally, we are not attempting to make the engineer something other than an engineer. Engineering is, after all, more a type or form of thought than it is the practical use of a knowledge of certain facts. We would have the engineer extend the application of his thought processes more widely than he generally has in the past, but we would have him remain essentially an engineer. An announcement of the program that has been formulated and which was covered in an editorial in the August number of MECHANICAL ENGINEERING[2] will indicate very plainly that the intention is to make better engineers, not to convert engineers into something else.

[2] See "Development of the Engineer," MECHANICAL ENGINEERING, August, 1932, p. 567.



ASHTABULA PLANT,
CLEVELAND ELECTRIC
ILLUMINATING COMPANY,
CLEVELAND, OHIO

Courtesy Cleveland Electric Illuminating Co.

CENTRAL-STATION PLANT *and* PERFORMANCE[1]

Data on Practice in Large Modern American Central Stations

By A. G. CHRISTIE[2]

STEAM pressures in recent American central stations are in the range of 450, 600, or 1200 lb per sq in. Temperatures vary from 700 to 825 F, with one plant at 850 F. Plants with 1200 lb pressure have operated satisfactorily, and the expected economies have been realized. One builder offers turbines for 1200 lb per sq in., 1000 F, with no reheat. The trend is toward higher pressures and temperatures.

All recent turbines are bled at one to five points for regenerative feed heating. Turbines for 600 and 1200 lb usually have one stage of reheating. Flue-gas reheaters give the highest station economy, but steam reheaters suffice where it is only desired to decrease moisture at exhaust. These two types are combined in several plants to secure constant reheat temperatures.

COAL SUPPLY

Recent installations of coal silos outside the boiler room and of coal storage in outdoor piles indicate a trend toward the total elimination of the inside coal bunkers. These changes reduce station cost and improve boiler-room lighting. Coal is handled by rotary car dumpers, drag scrapers, locomotive cranes, belt conveyors, or skip hoists. Recent plants have complete coal weighing and sampling equipment.

STEAM-GENERATING UNITS

Cross-drum horizontal, two-drum vertical, Stirling, and other types of water-tube boilers are in service. The use of single-pass boilers is increasing since these cose less, permit simpler boiler

[1] Second section of a paper entitled "Production and Transformation of Electrical Energy in the United States," by Alex. D. Bailey, A. G. Christie, F. A. Allner, and F. C. Hanker, contributed but not presented to the International Electrical Congress, Paris, France, June, 1932. The first section, by Alex. D. Bailey, was published in the August issue of MECHANICAL ENGINEERING. The third section, by F. A. Allner, will appear in the October issue.

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TABLE 1 DATA ON RECENT BOILER PLANTS

Name of station	Year	Mfr	Pressure, lb per sq in.	Temp, deg F	Heating surface (H. S.), sq ft	Max. rating, lb per hr	Lb steam per sq ft H. S. per hr	Furnace volume, cu ft	Heat liberated, Btu per cu ft per hr	Furnace bottom
Deepwater	1930	B. W.[1]	1400	760	9,623	330,000	34.3	19,080	22,640	Slag tap
Huntley No. 2	1930	B. W.	500	765	40,107	560,000	13.9	22,900	38,310	Slag tap
Hell Gate	1930	B. W.	360	770	58,152	1,000,000	17.2	42,500	26,200	Slag tap
East River	1929	C. E. Co.[2]	440	750	60,706	1,250,000	20.6	38,200	29,400	Water screen
State Line	1929	B. W.	800	790	14,735	450,000	30.6	16,700	34,500	Slag tap
Atkinson	1930	C. E. Co.	475	750	30,200	450,000	14.9	25,120	22,500	Air-cooled hopper and hearth screen
South Amboy	1930	B. W.	1400	750	13,673	275,000	20.1	12,900	26,500	Slag tap
Holland	1929	B. W.	1400	750	10,122	300,000	29.6	16,500	20,000	Hearth screen
Cahokia	1929	B. W.	330	750	19,836	200,000	10.1	14,650	19,900	Water-cooled hopper
Gorgas	1929	B. W.	475	750	33,805	500,000	14.8	24,000	22,500	Hearth screen, air-cooled ash hopper
Gould St.	1927	B. W.	450	720	30,156	519,000	17.2	21,000	33,300	Water screen
Ashtabula	1930	B. W.	395	725	32,560	416,000	12.8	32,560	14,000	Water screen
Powerton	1930	B. W.	650	725	30,000	275,000	9.2	13,900	28,000	Slag tap

[1] Babcock & Wilcox Co. [2] Combustion Engineering Corp.

TABLE 2 PERFORMANCE DATA OF CERTAIN AMERICAN CENTRAL

	Name of station.....	Cahokia	Hudson Ave.	Kearny	Ashtabula	East River	Richmond	Trenton Channel	James H. Reed
	Owner.....	Union Elec. Light and Power Co.	Brooklyn Edison Co.	Pub. Serv. Co. of N. J.	Cleveland Elec. Illumg. Co.	N. Y. Edison Co.	Philadelphia Elec. Co.	Detroit Edison Co.	Duquesne Light Co.
	Location.....	St. Louis, Mo	Brooklyn, N. Y.	Kearny, N. J.	Cleveland, O.	New York, N. Y.	Philadelphia, Pa.	Detroit, Mich.	Pittsburgh, Pa.
1	Operating pressure and temp.	335 lb, 725 F	279 lb, 602 F 415 lb, 708 F	365 lb, 689 F	375 lb, 700 F	385 lb, 750 F	398 lb, 657 F	400 lb, 700 F	400 lb, 720 F
2	Total installed capacity, kw..	235,000	450,000	214,500	150,000	280,000	120,000	300,000	60,000
3	Unit capacity of turbines and rpm.....	1—75,000 1—50,000 1—40,000 2—35,000 } 1800	2—110,000 } 1200 1—80,000 } 3—50,000; 1800	3—40,000 2—47,000 All 1800 rpm	50,000; 1800	Nos. 1,2—60,000; 1500 No. 4—160,000; 1500 (25-cycle)	60,000; 1800	50,000; 1800	60,000; 1800
4	Type and size of steam reheater in sq ft H.S.....	None	None	None	None	None	None	None	None
5	No. of bleeder heaters.....	1 to 4 per unit	2 and 4	4	2	3 stages	3	3	3
6	Final temp. of feed, full load.	290 F	285 F 390 F	340 F	190 F	Nos. 1,2—344 F No. 4—360 F	310 F	250 F	290 F
7	Total no. of boilers.....	19	24	15	6	9	12	13	8
8	Sq ft of boiler surface per unit	18,010 23,500	12—19,560 4—22,920 4—23,764 4—24,700	A—12—23,600 B—3—22,900	32,560	6—18,943 3—61,451	15,697	30,300	35,025
9	Sq ft economizer surface per unit.....	None	4—14,970 4—21,420	None	23,232	None	7,515	18,850	13,572
10	Sq ft air-preheater surface, per unit.....	2,180	4—43,296	91,400 on B	None	6—28,900 3—82,721	22,072	None	None
11	Max. boiler output per unit, lb per hr.....	220,000	12—146,000 4—235,000 8—312,000	12—250,000 3—310,000	416,000	6—280,000 3—1,250,000	200,000	350,000	375,000
12	Avg. boiler-plant efficiency per unit.....	80.5%	12—74.3% 12—84.8%	80%	87.3%	85%	88.2%	88.3%	81.2%
13	Type of furnace equipment.	P.C.	Stoker	Stoker	P.C.	P.C.	Stoker	P.C.	Stoker, water walls
14	Condenser surface, sq ft per unit.....	No. 5—53,000	Nos. 1, 2, 3—70,000 No. 6—88,500	3—43,000 2—50,000	57,000	Nos. 1,2—47,500 No. 4—90,000	70,000	3—31,806 3—51,000	55,000
15	Max. cooling-water temp.....	90 F	76 F	89 F	82 F	78 F	84 F	77 F	85 F
16	Min. cooling-water temp.....	32 F	35 F	34 F	32.5 F	32 F	35 F	34 F	33 F
17	Gross annual output, kwhr...	987,512,000	1,555,932,126	1,176,853,500	293,939,000 for 8 mo.	.....	778,644,811	889,669,400	452,302,080
18	Auxiliary use, kwhr.....	53,187,000	79,991,391	51,291,180	12,074,000	.....	32,702,042	45,741,400	9,331,890
19	Net annual output, kwhr....	934,325,000	1,475,940,735	1,123,538,500	271,865,000	1,205,165,000	745,942,769	843,920,300	342,970,110
20	Avg. cost of coal, 2000 lb per ton.....	$2.21	$4.08	$4.68	$2.85	$4.08	$4.205	$3.435	$2.25
21	Avg annual station performance, Btu per kwhr.....	15,860	15,460	16,320	13,650	15,850	13,480	14,505	15,020
22	Annual load factor.....	60.94%	50.75%	64%	48.5%	55.6%	74.1%	47%	55.9%
23	Annual use or capacity factor	47.9%	39.47%	62.6%	32.3%	49.1%	74.1%	34%	65.3%

Pressure in lb gage. H.S. = heating surface. P.C. = Pulverized coal.
Boiler efficiencies based on higher heating values of fuel.

plant, carry higher ratings, and have lower draft losses than multi-pass units. A few boilers with welded drums are in service. The trend is toward the use of units of great capacity, both in square feet of heating surface and in steam output. A boiler at the East River Station, New York, contains 60,706 sq ft of water-heating surface and has produced 1,250,000 lb of steam per hour. Maximum tube length is 36 ft. Certain new boilers have a small amount of water-heating surface, often single pass, followed by large superheating, steaming-economizer, and air-heater surfaces. Centralized boiler control is becoming standard practice. Table 1 presents data on some recent boiler plants.

"Unit" system plants with one boiler per turbine, each with its essential auxiliaries, as, for example, the Gould St. Station, Baltimore, Md., are now in service. A recent study[3] shows that the availability factor of large-output boilers is about 85 per cent, while the average availability factor for turbines is about 90 per cent. The availability factor for boilers appears to increase and the cost of maintenance per million pounds of water evaporated, to decrease with increased boiler output. High-pressure plants have proved reliable. In 1931, the 1300-lb section of Lakeside Station, Milwaukee, had availability factors over 90 per cent for both boilers and turbines. The high efficiency of large steam generators is maintained over a wide range of load. Large-output boilers appear to be the most economical units to install in a new plant.

Both convection and radiant superheaters and reheaters are in use. Combinations of convection and radiant surfaces give almost constant steam temperatures at all boiler loads.

Boiler-water conditioning, especially at high pressures, is receiving much attention. The maintenance of proper sulphate-alkalinity ratios has overcome caustic embrittlement. Foaming and priming at high ratings, when boiler-water concentration is high, cause impurities to be carried over to the turbine. These close the blade passages and decrease output. Such scale deposits, provided they are soluble in water, may be removed by washing with wet steam while the turbine is in service. The problem of washing is growing in importance and may ultimately become a major consideration in plant operation.

Steaming economizers are used with high-temperature feedwater. Air heaters serve with or without economizers to pro-

[3] "Performance of Modern Steam-Generating Units," by C. F. Hirshfeld and G. A. Moran, presented at the Annual Meeting of the A.S.M.E., December, 1931.

STATIONS FOR THE PERIOD NOV. 30, 1930, TO NOV. 30, 1931

Gould St. Cons. Gas E. L. & P. Co. Baltimore, Md.	Long Beach Southern Calif. Edison Co. Long Beach, Calif.	Crawford Avenue Commonwealth Edison Company Chicago, Ill.	Phile Ohio Power Co. Phile, O	Powerton Super Power Co. of Illinois Powerton, Ill.	State Line Chicago District Electric Gen. Co. Hammond, Ind.	Lakeside The Milwaukee Elec. Light & Power Co. Milwaukee, Wis	Deepwater American G. & E. Co. & U. G. I. Co., Deepwater, N. J.
400 lb, 715 F	410 lb, 750 F	572 lb, 707 F	600 lb, 725 F	630 lb, 725 F	660 lb, 730 F	290 lb, 700 F 1230 lb, 750 F	1250 lb, 750 F
72,000	200,000	424,000	245,000	215,000	208,000	310,800	106,000
2—36,000; 1800	2—100,000; 1500 (50-cycle)	No. 1—51,000; 1800—720 No. 2—60,000; 1800—1200 No. 3—50,000; 1800—1800 No. 4—75,000; 1800—1200 No. 5—88,000; 1800—1200 No. 6—100,000; 1800—1800	A—2—40,000; 1800 1 h-p, 2 l-p, B—55,000 each; 1800	No. 1—55,000; 1800 No. 2—55,000; 1800 No. 3—105,000; 1800	208,000; 1800	Nos. 1,2—20,000; 1800 Nos. 3,4,5,6—30,000; 1800 Nos. 9,11—60,000; 1800 Nos. 7,8,10,12—7700; 3600	2—53,000 h-p—3600 rpm l-p—1800 rpm
None	None	1—17,458 1—16,124 No. 5—9,000 (steam) No. 6—17,980 (steam)	2—5,031 2—4,734	No. 1—20,856 No. 2—20,856 No. 3—32,400	2 heaters—17,980 (steam)	Boiler No. 17, radiant, 690 sq ft Boilers Nos. 18, 19, 20, convection, 7800 sq ft	2—11,781
4 stages	4 stages	No. 1 unit, 3 stages; all others, 4 stages	A—6 stages B—8 stages	4 stages	5 stages 2 heaters per stage	5 units—1 stage 3 units—4 stages	4 stages
367 F	395 F	No. 1—315 F; No. 2—310 F No. 3—310 F; Nos. 4, 5, 6—310 F	190 F 330 F	350 F	415 F	360 F (4-stage)	434 F
[illegible]	6	No. 1—4 S & 1 R; No. 4—5 S* 2 reheat No. 2—4 S & 1 R; No. 5—6 S 6 stan. No. 3—4 S & 1 R; No. 6—6 S	A & B	6 Standard 3 Reheat	6	No. 1—16—305 lb No. 17—20—1300 lb	6
Boiler, 30,156 Superheater, 5,771	34,162 per boiler	Nos. 1, 2, 3—15,676 sq ft (each boiler) Nos. 4, 5, 6—17,280 sq ft	A—47,289 B—138,774 (total)	Nos. 1-3; total, 43,328 Nos. 4-6; total, 43,328 Nos. 7-9; total, 65,501	Boiler—10,294 Superheater—7,200	Nos. 1-8—13,330 Nos. 9-16—18,280 No. 17—30,590 Nos. 18-20—28,845	9,623
None	None	Nos. 1, 2, 3—10,250 sq ft (each economizer) Nos. 4, 5, 6—7,376 sq ft	A—35,384[b] B—94,632 (total)	Nos. 1-3; total, 12,252 Nos. 4-6; total, 12,252 Nos. 7-9; total, 41,166	19,820	Nos. 1-8—7,603 Nos. 9-16—14,856	4—18,326 2—4,765
26,772	51,232 per boiler	Nos. 1, 2, 3—10,000 sq ft (each preheater) No. 4—15,670 sq ft No. 5—16,000 sq ft No. 6—17,280 sq ft	A—None B—423,200 (total)	Nos. 1-3; total, 84,909 Nos. 4-6; total, 84,909 Nos. 7-9; total, 164,934	56,401	No. 17—67,300 Nos. 18-20—77,500	42,693 (total)
350,000	450,000	Nos. 1, 2, 3—150,000 (per boiler) Nos. 4, 5, 6—200,000	A—508,000 B—2,350,000 (total)	Nos. 1-3; total, 710,000 Nos. 4-6; total, 710,000 Nos. 7-9; total, 1,150,000	450,000	Nos. 1-8—90,000 Nos. 9-16—150,000 Nos. 17-20—300,000	4—350,000 2—290,000
81.26%	84%	79.8%	A—79% B—81%	83.4%	84.5%	Nos. 1-8—88.35% Nos. 9-16—90.38% Nos. 17-20—86.42%	87.5%
P.C.	Gas and fuel oil	Forced-draft chain-grate stokers	A—Chain grates B—16 Chain grates 2 P.C.	P.C.	P.C. and nat. gas	P.C.	P.C.
2—30,000	2—80,000	No. 1—56,000; No. 4—77,000 No. 2—75,000; No. 5—70,520 No. 3—65,000; No. 6—90,000	A—50,000 B—110,000	No. 1—50,000 No. 2—50,000 No. 3—90,000	8 condensers, 22,000 sq ft each	2—35,000 3—50,000 1—25,000 2—55,000	42,500
85 F	76 F	75 F	82 F	88 F	80 F	75 F	90 F
34 F	53.8 F	34 F	33 F	33 F	40 F by recirculation	35 F	35 F
21,081,600	1,400,579,800	2,025,283,640	982,765,600	1,217,149,600	1,104,794,000	931,831,245	855,350,879
17,807,000	45,954,258	95,209,400	53,556,920	81,063,700	64,041,000	59,843,015	67,800,000
303,574,600	1,354,615,642	1,930,074,240	929,727,880	1,136,085,900	1,040,753,000	871,988,230	787,550,879
$3.85	Gas—$0.1185 per 1000 cu ft, 1158 Btu per cu ft; Oil—$0.80 per bbl. of 6,250,000 Btu	$3.69	$1.70	$2.85	$3.80	$4.00	$3.85
14,425	13,268	14,845	13,587	12,823	13,572	13,716	11,850
52.75%	86.13%	60.4%	48%	61.5%	66.4%	47.3%	87.0%
50.95%	77.32%	52.0%	46%	67.1%	60.63%	34.2%	80.0%

* S = Standard boiler; R = Reheat boiler [b] Air-water heat exchanger

vide air temperatures in the neighborhood of 350 F for stokers and 400 to 650 F for pulverized coal.

Water-cooled furnace walls with exposed tubes, fin tubes, or tubes faced with bare or refractory-coated cast-iron blocks, are installed under nearly all large-output boilers with either stokers or pulverized coal. Such side walls in stoker plants prevent the adherence of fused ash to the setting.

The high heat-absorption rates prevailing in large-output boilers and in water walls have developed problems of water circulation and of water levels in drums. These difficulties are being studied and should be corrected in new designs. Frequently drums of horizontal water-tube boilers are placed at a high elevation to provide a greater static head on the water in the tubes. Dry-steam drums are also coming into use on large boilers.

Usually motor-driven centrifugal pumps furnish feedwater to boilers, with a steam-driven unit for reserve or emergency service. Quick starting is an important characteristic of feed pumps. Motor-driven multiple-plunger feed pumps will be installed in a new 1200-lb plant where their overall efficiency of 77 per cent at full load is sufficient justification for their higher cost and greater floor-space requirements.

Feedwater is deaerated or otherwise deoxidized before entering the boilers. Make-up water to high-pressure boilers is generally distilled.

FURNACE EQUIPMENT

The projected area, fuel-burning capacity, and efficiency of underfeed stokers have greatly increased. A recently installed stoker will burn 73 lb per sq ft per hr on 694 sq ft at a heat liberation in the furnace of 51,000 Btu per cu ft per hr. Zoned air control, improved pusher mechanism, better tuyères, water-cooled side walls, deeper ashpits, and more rugged clinker grinders characterize the newer units. Heat-liberation rates vary from 20,000 to 80,000 Btu per hr per cu ft of furnace volume with stokers. Forced-draft chain-grate stokers are used for free-burning coals, lignites, and anthracite. The largest chain grate has 528 sq ft of surface, burns 65 lb of coal per sq ft per hr at maximum output, and has a furnace heat release of 42,000 Btu per cu ft per hr.

The unit system of pulverized-coal firing is gaining in favor as it provides a cheaper and simpler plant than the central system. Unit mills having capacities up to 50 tons per hour are in operation. Burners are still being improved. Those of the turbulent-mixing type give better combustion and require smaller furnaces than the earlier long-flame burners. Systems of boiler control provide instant response to changes in steam demand. Their use lessens labor and over long periods results in higher boiler and furnace efficiencies than could be secured by hand control. Coal is now dried in the pulverizers by preheated air. Vent discharges are delivered to the furnace, thus eliminating former dust nuisances. Many new boilers under which coal with low-fusing ash is burned are provided with furnaces having vertical coal firing, and with water-cooled refractory-lined bottoms on which the ash accumulates as liquid slag and from which it is tapped off in liquid form. A greater proportion of the total ash in the coal is retained in the slag than would be deposited in dry-bottomed furnaces.

Recent practice indicates a heat release in powdered-coal furnaces of 12,000 Btu per cu ft per hr for plain refractory walls, 16,000 for air-cooled walls, and 24,000 to 38,000 for water-cooled walls. Average yearly efficiencies of boiler plant of 80 to 88.3 per cent, based upon the higher heating value of the fuel, have been obtained as shown in Table 2.

The limitation of boiler capacity through the deposit of ash as slag on the tubes above stoker and pulverized-coal furnaces has been overcome by a rearrangement and wide spacing of the first boiler tubes in the form known as a "slag screen." This slag screen cools and hardens the ash particles by absorbing their radiant heat before contact with the tubes, so that the ash passes on as dust.

Ashes and slag are usually sluiced with water from below the furnaces to a central pit. The material which settles is removed by a grab bucket.

Many forms of dust catchers, precipitators, and gas washers to remove both ash and undesirable gases are under development to clean chimney discharges, but the problems of cleaning flue gases are not yet completely solved.

Gas and oil are widely used boiler fuels. They offer fewer combustion difficulties than coal. The extension of natural gas pipe lines will increase the use of this fuel for power development, particularly for stand-by and off-peak services.

The efficient utilization of waste fuels such as sawdust, wood chips, refinery refuse, etc., for steam production has been greatly extended in recent years.

STEAM TURBINES

Sixty-cycle turbines operate at 3600 and 1800 rpm, with a few at 1200 rpm. The capacity of a given casing is limited by the allowable length of the last blades and by the permissible leaving losses. A maximum tip speed of 1200 ft per sec has been reached, and in certain cases, leaving losses have amounted to 7 per cent of the adiabatic heat drop. Single-cylinder units of 80,000 kw and tandem units of 160,000 kw capacity, all at 1800 rpm, are in operation. The largest single-cylinder condensing unit at 3600 rpm is rated at 10,000 kw, while tandem condensing units of 15,000 kw capacity are installed at this speed.

Difficulty has been experienced with erosion by moisture in the last rows of blades due to insufficient superheat for the range of expansion. Much attention is being given to this problem. Heavy round-edged blade sections are used in place of the earlier feather-edged blades. Various blade materials such as stainless steel, nitralloy, heavy chrome-plated steels, and blades shielded with tungsten, tantalum, and stellite, are under trial. Schemes for removing moisture from the last stages of steam turbines appear to be effective in some units, but of little benefit in others. This problem has not been fully solved.

The Detroit Edison Company's turbine of 10,000 kw capacity with initial conditions of 375 lb and 1000 F has operated satisfactorily at this temperature. Its performance will in all probability lead to a substantial increase in initial steam temperatures for new power plants.

Disk and blade vibration has been largely overcome through improvements in design. A careful inspection of all blades is now made at the time of the annual overhaul to locate and remove any blades showing fatigue lines or cracks.

The use of a high-pressure oil supply to float the bearings and of motor-driven turning gear has enabled operators to shorten starting time and to eliminate wear of bearings.

Closed bleeder heaters are generally used, but jet heaters are increasing in number. Evaporators to furnish distilled make-up water form part of the bleeder feed-heating system. Deaeration is generally effected in one of the bleeder heaters. Electric generators are provided with air coolers, most of which form a part of the feed-heating system. Air-circulating fans are usually fastened to the generator rotor, though separate fans are used with some large generators.

Both high- and low-pressure turbine glands usually have water seals. These require more power than labyrinth packings, but, by absolutely preventing steam leakage, make-up requirements are decreased, and troublesome roof condensation in cold weather is eliminated.

CONDENSERS

A vacuum of 29 in. is specified and secured where cooling water of 55 F or less is available for the greater portion of the year. In southern plants with 70 F water, a 28½-in. vacuum must suffice. River-water temperatures vary widely between summer and winter (e.g., at St. Louis, from 32 to 90 F), and this has a considerable effect upon station economy.

Four trends characterize recent condenser practice. Better distribution of cooling surface has increased its effectiveness and lessened the pressure drop through the tube bank. Undercooling of the condensate is prevented by introducing exhaust steam into the hot well. Leakage of cooling water into the condensate has been practically eliminated by rolling both ends of the tubes into the tube sheets, which latter may be floating or fixed. Effective subcooling of the air-pump suction has increased the available vacuum.

Single-pass condensers are favored where ample supplies of cooling water are available at a low head. Two-pass condensers are installed when the cooling water is limited or where the lift is high or extremely variable as on certain rivers and tidal waters. Table 3, from N.E.L.A. sources, gives some figures on American practice with single- and two-pass condensers. Tube sizes are usually ⅞ in. diameter in single-pass and 1 in. diameter in two-pass condensers. The largest condenser is at the Hudson Ave. Station, Brooklyn, N. Y., and contains 101,000 sq ft of surface.

The use of welded plate construction for the condenser shell is increasing, as this decreases weight and first cost. Steam-jet vacuum pumps are almost universally used.

Tube surfaces must be kept clean to insure the best station performance. Cleaning by various devices such as scrapers, high-pressure water jets, sand blasting, rubber plugs, etc., is only partially effective. Divided water boxes which permit cleaning in service are also employed. In many plants chlorination of the cooling water to prevent algae growth in the tubes has proved effective and economical in keeping tubes clean.

Traveling screens are standard equipment on the intakes of cooling-water channels. These intakes are located as far below the water surface as possible to draw from the cooler water at the lower depths.

TABLE 3 CONDENSER DATA

(N.E.L.A. Report, 1930)

Kilowatt rating	Sq ft per kw — Single-pass	Sq ft per kw — Multi-pass	Gpm per kw — Single-pass	Gpm per kw — Multi-pass	Average size, kw
50,000 and over	0.70	0.95	1.28	1.00	78,000
30,000 to 50,000	1.05	1.00	1.60	1.27	37,500
To 30,000	1.45	1.43	2.18	1.60	15,200

As shown in Table 3, large quantities of cooling water are pumped per pound of condensed steam on account of the higher water temperatures in summer and the demand for the lowest absolute exhaust pressure consistent with the prevailing load and the leaving losses of the turbines.

PIPING

Considerable study has been devoted to the design of piping and valves for high pressures and temperatures, and to researches on the flexibility of such pipe systems. Various forms of welded joints for high pressures, such as the Sarlun and the Sargol, and of other joints with gaskets of different metals, are in satisfactory use.

The creep rates and properties of alloys for high temperatures are being investigated in several laboratories, and satisfactory materials for use at 1000 F will soon be available.

All water, air, gas, oil, and low-pressure-steam piping is now welded.

STATION PERFORMANCE

Station performance is determined by the economic influences upon the unit cost of power of the price of fuel, load factor, and rate of system growth. Moderate load factors and low fuel costs do not warrant large plant investments to secure high thermal efficiency. On the other hand, when fuel costs and load factors are both high, thermal efficiency becomes a major factor, and plants are designed to secure the best possible performance.

The first cost of steam stations per kilowatt of capacity has been decreasing steadily during the past few years, and will continue to decrease with the more extended use of both turbines and boilers of large capacity. The cost per kilowatt for

Courtesy Sargent and Lundy, Inc.

POWERTON PLANT, SUPER POWER COMPANY OF ILLINOIS, POWERTON, ILL.

stations with steam conditions of 1200 lb and 800 F does not appear to be $5 per kw greater than the unit cost of stations for 450 lb and 750 F. The decrease in fuel consumption of late years in American central stations has been remarkable. From 1919 to 1931 the average coal consumption per kilowatt-hour dropped from 3.2 to 1.56 lb.

Table 2 gives performance data on some American central stations with different operating conditions and fuel costs.

MEANS FOR REDUCING POWER COSTS

The cost of power consists principally of fixed charges upon the investment in plant, and of operating and maintenance expenses. Plant investment can be reduced as noted above. If higher pressures and temperatures are employed, fuel costs can be reduced. Unit combinations of one boiler-one turbine will simplify piping and auxiliary arrangements, and, by permitting full automatic operation, will lower operating costs. Many turbines are now purchased with most economical load at 60 per cent of rating. This allows a margin for peak-load and emergency demands. All unit costs are reduced when load and capacity use factors are substantially increased.

TABLE 4 COMPARATIVE OPERATING CONDITIONS OF MERCURY-VAPOR PLANTS

	Hartford	Kearny	Schenectady
Load on mercury turbine, kw	10,000	20,000	20,000
Speed of mercury turbine	720	900	900
Total steam from unit, lb per hr	129,000	325,000	325,000
Steam pressure, lb gage	275	365	400
Steam temperature, deg F	680	750	760
Mercury-vapor pressure at turbine, lb gage	70.7	125	125
Mercury-vapor temperature at turbine, deg F	884.5	958	958
Vacuum of mercury condenser, in. abs	1.5	3	3
Temperature of mercury vacuum, deg F	440	485	485

Attention is being directed to the possibilities of reconditioning and increasing the capacities of old stations. These can often carry the low load-factor portion of the demand at least total cost. Frequently this reconditioning provides added system capacity at less cost than can be secured by any other means.

The elimination of the power-house structure to lower first cost of plant is under consideration. Two out-of-doors plants are being constructed, one with the boilers unhoused, and the other with the turbines outside. The elimination of superstructure may not offer as great an opportunity for cost reduction as simplification of design.

BINARY-VAPOR PLANTS

Diphenyl oxide is being circulated through economizers in one of the newer stations and serves to preheat air entering the furnace. It is proposed to use diphenyl oxide in a new station both to superheat the high-pressure steam and to reheat it between cylinders.

A mercury boiler and turbine have operated successfully in series with a steam turbine at one of the plants of the Hartford Electric Light Company. This plant delivered power to the switchboard for a year at an average fuel consumption of 10,250 Btu per kwhr.

Two mercury plants of 20,000 kw capacity are under construction. One, at Schenectady, N. Y., will deliver power to the New York Power and Light Company and will send 325,000 lb of steam per hour to the works of the General Electric Company. The other, at Kearny Station of the Public Service Electric and Gas Company of New Jersey, will deliver steam to turbines in which 33,000 kw will be generated, thus making, with the 20,000 kw from the mercury turbine, a total output of 53,000 kw for the combined mercury-steam unit. Table 4 gives details of the three plants.

The mercury-vapor plant appears to be economically justified on a system where fuel costs are high or where the unit with its accompanying steam turbine can be given a constant heavy loading through the year.

GENERAL TREND OF DEVELOPMENT

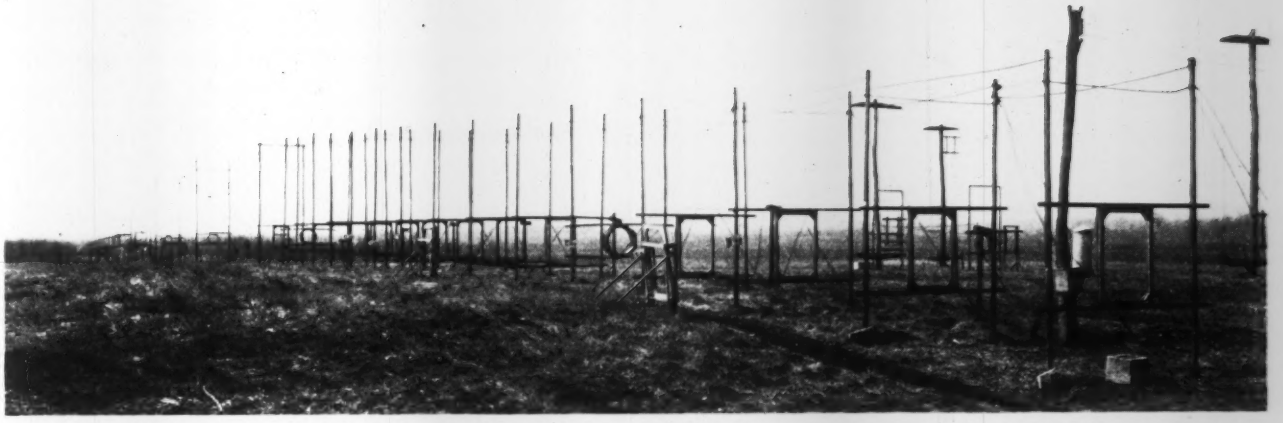
American central-station plant is still undergong change and development to increase reliability, simplicity, and efficiency. While much has been achieved, many improvements can still be made. Higher operating pressures and temperatures are now recognized as practical and economically justified. The present trend is toward the production of more kilowatt-hours from every dollar of total expense.

Silk

(*Continued from page 628*)

ment in silk held by the Japanese government had therefore some social justification even if it proved to be an apparently complete failure economically.

That the effort to stabilize silk proved so unsuccessful carries an important lesson to all those who are considering attempts to manipulate the fundamental laws of supply and demand without absolute certainty of controlling the supply factor. Here we have a country, the largest producer of silk in the world, in which there are no restrictions as to curtailing competition such as are imposed by the Sherman and Clayton acts in this country, and in which the government, while formally a constitutional monarchy, is practically unrestricted in its power of control of the markets except in so far as the laws of economics and human nature may impose limits. And yet, in the face of a hold-over supply of 120,000 bales, the government proved to be incapable of restricting production within its own limits and still less able to maintain the level of prices in the markets of the world. The silk-price-control fiasco may therefore be taken as a striking example of essential inability to manipulate prices of a commodity in the world market unless such manipulation happens to be in the right direction and supported by economic phenomena independent of the manipulative authorities. In other words, it is possible to manipulate the prices of a commodity upward when they would have gone upward even if there had been no manipulation. This is beautifully illustrated by the success of the first two silk taishans. It is an entirely different proposition, however, to attempt to move prices upward by manipulation in the face of a declining market. As shown by the history of the silk market within the last decade, manipulation of prices of a commodity is unnecessary under conditions that apparently will render it successful if attempted. Where, however, the prices do not rise of themselves, an attempt to boost them by manipulation is likely to be no more successful than the proverbial effort to lift one by one's own bootstraps.



PHOTOGRAPH OF THE RANGE USED IN DETERMINING THE FORCES ACTING ON A PROJECTILE

The Rôle of Model Experiments in PROJECTILE DESIGN[1]

By R. H. KENT[2]

BY TOWING model ships in a tank and measuring the forces acting upon them as a function of their shape and speed, very important advances in the speed of vessels and in the saving of power have been effected. The well-nigh indispensable assistance which force measurements on model planes in wind tunnels have given the airplane designer is well known. The usefulness of model experiments to the projectile designer in augmenting the range and reducing the dispersion of guns should be evident. However, mainly because the requisite technique was lacking, it is only since the war that such experiments have been carried out systematically and extensively, and that the designer has based his designs upon knowledge of the forces acting upon the projectile as affected by its shape, air speed, etc., obtained from such model experiments.

The military advantages of attaining the maximum possible projectile range with a given weight of gun and carriage are of course apparent. The extent to which the ranges of projectiles launched with velocities of half a mile a second or more are limited by the very considerable resistance of the air, is, at first sight, amazing. For example, the actual maximum range of the latest service bullet fired from the Springfield rifle with a velocity of 2700 fps is 5600 yd or about three miles. If some way of reducing the air resistance to zero, as in vacuo, could be found, the range would be increased to 75,600 yd or 43 miles. As the caliber of the projectile increases, the relative effect of the air resistance diminishes, but still remains important. The latest model of the 75-mm gun has a range of about 15,000 yd in air, while in vacuo its range would be approximately 49,000 yd. It is evident from these examples that the problem of reducing the air resistance of projectiles is a very important one from the standpoint of the designer. It is apparent also that model experiments should effectively contribute to its solution.

While great range is, from a military point of view, a very important attribute of a projectile, it is not, after all, as important as accuracy or precision in range. It does not help the battery commander much to have guns with ranges of 10 miles if they are so inaccurate that from the fall of one shot he cannot predict with reasonable precision where the next one will fall. Now aside from varying atmospheric conditions, which are not subject to human control, the variation in range from shot to shot depends almost entirely upon variations in muzzle velocity and in the resistance of the projectile as dependent upon variations in its shape from round to round and also in its presentation. Of course, there are other factors such as the weight of the projectile, but these may easily be kept constant or allowed for.

The problem of obtaining constancy in velocity from round to round primarily concerns the powder engineer. The projectile designer, hoping that his colleague will solve the powder problem, is interested in discovering the effect of changes in the shape and presentation of the projectile upon the range. In the solution of problems of this sort, model projectile experiments have been found to be a tool of even greater effectiveness and importance than in the solution of the problem of the attainment of great range itself.

Before describing the model experiments which are used to measure the forces acting on the projectile, the motion of the projectile will be described in general terms and the important forces acting will be enumerated.

For the sake of simplicity, consider first a projectile which

[1] Published by permission of the Ordnance Department, U. S. A.

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is traveling "nose on," that is to say, one in which the axis of symmetry coincides in direction with the trajectory. For such a projectile as this, aside from a couple which tends slightly to reduce the spin, the only important forces are gravity and the head resistance or drag, which in this case will have a direction exactly opposite to that of the flight of the projectile relative to the air. Consider a projectile of a given mass and shape leaving the gun with a given velocity, its trajectory making a given angle with the horizontal. Assuming that the head resistance for the given projectile is

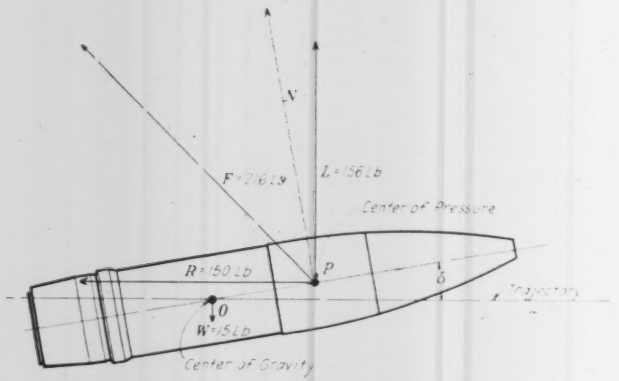

FIG. 1 THE FORCE SYSTEM OF A YAWING PROJECTILE

(In addition to the head resistance R and the normal force N, the cross-wind force L is shown. The cross-wind force is the force perpendicular to the trajectory and is the force which produces the well-known right drift of projectiles fired from guns with a right-handed twist. The forces indicated are those acting on a 75-mm projectile with an air speed of 2175 fps.)

known as a function of the air density and air speed, the initial acceleration along the vertical and along the trajectory are known and the position of the projectile at any future time may be computed, assuming of course that the air density at all parts of its path is known.[3]

Of course, the actual projectile does not move exactly nose on. However, the assumption that it does is found to be a sufficiently close approximation at least for certain well-behaved projectiles, for the purpose of computing a magnitude of great interest to the projectile designer, namely, the maximum range. In order that this computation may be made, it is necessary, as we have seen, that the head resistance R be known as a function of the air speed and air density for the given projectile. The manner in which R is determined as depending upon these variables from the model experiments will be explained later.

In the preceding paragraphs it was assumed that the projectile moves exactly nose on. On this assumption, the motion of a projectile may be treated as that of a material particle. As has been intimated, however, this is a sufficiently good approximation only in the case of the well-behaved projectiles, which do move approximately nose on. In the case of other projectiles, however, this approximation is no longer adequate and it becomes necessary to treat the projectile more realistically as a solid body free to move about its center of gravity.[4]

Consider a projectile (Fig. 1) that is not moving exactly nose on. In this case the axis of symmetry makes an angle δ, called the angle of yaw, with the direction of motion. As a consequence of the oblique presentation, the resultant air force F acting no longer coincides with the trajectory, but intersects the axis of the projectile at a point P, called the center of pressure. For convenience in treating the motion of the projectile about its center of gravity O, we find the component of F perpendicular to the axis and call it the "normal force" N.

It is evident that the force N, since in the case of the ordinary artillery projectile its point of application is forward of the center of gravity, will produce a couple M, equal to $(OP) \times N$ which will tend to overturn the projectile unless prevented from doing so by its spin. It is apparent that N should increase as δ increases, and it has been found that for small angles of yaw, N is proportional to $\sin \delta$. It follows that M is also proportional to $\sin \delta$, whence

$$M = \mu \sin \delta$$

where μ is a proportionality factor and is called the "couple factor."

The behavior of a projectile may be usefully compared with that of a top. In the case of a top, its point replaces the center of gravity O of the projectile, and the center of gravity of the top replaces the center of pressure P of the projectile (see Fig. 2). If the mass of the top is m, the resultant force acting is mg and the component normal to its axis is

$$mg \sin \delta$$

if δ is, in the case of the top, the angle between the axis and the vertical. In the case of the top, accordingly,

$$M = (OP) \times mg \sin \delta$$

and

$$\mu = (OP) \times mg$$

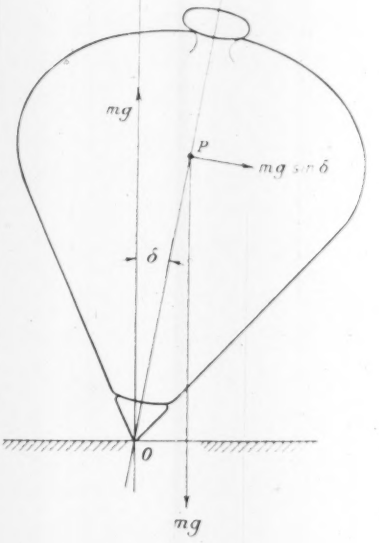

FIG. 2 THE FORCE SYSTEM OF A TOP

It is a matter of common knowledge that if a top is spun sharply enough, its axis will continue to move for a considerable time—i.e., until the spin dies down—in the vicinity of the vertical, even if it is given small knocks tending to upset it. In the parlance of mechanics, the motion of the axis of the top about the vertical is said to be stable. In case the spin is insufficient, the axis leaves the vertical and the top

[3] Methods of computing trajectories have been elaborated by various mathematicians and ballisticians, American and foreign. At present, trajectories are being computed at Aberdeen Proving Ground by a method devised by Dr. F. R. Moulton, formerly of the University of Chicago, and Lieutenant-Colonel of Ordnance during the war. Recently the integrating machine of Professor Bush has been applied to the integration of trajectories with very promising results. For a description of this machine, see *Journal of the Franklin Institute*, October, 1931, pp. 449–488.

[4] The terminology and treatment are based on those given by Fowler, Gallop, Lock, and Richmond (Phil. Trans. Roy. Soc., series A, vol. 221, pp. 295–387). Fowler and his associates were the first to develop a useful theory of the yaw of a projectile and to test it by experiment. A treatment of the motion when the yaw is large, which has been found very useful, is given by Moulton in his "New Methods in Exterior Ballistics."

tumbles, the motion being unstable. In the case of the top the condition for stable motion about the vertical has been deduced by the aid of theoretical mechanics. It may be shown that the motion is stable provided

$$\frac{A^2N^2}{4B\mu} > 1$$

where A is the axial moment of inertia, B the moment about a transverse axis through the point, and N the spin in radians per second. As already stated, μ is the factor by which one multiplies $\sin\delta$ to obtain the overturning moment M.

For the case of the projectile, of course, a similar condition holds if A, B, N, and μ are given appropriate definitions. In general, if $A^2N^2/4B\mu$ is greater than unity the projectile will not tumble, while if it is less than unity, the projectile will tumble, resulting in a tremendous loss in range and in a very erratic flight. Because of its great significance in this connection, the quantity $A^2N^2/4B\mu$ is designated by a special symbol s, and is called the stability factor.

In view of the fact that a projectile will tumble if its stability factor is less than unity, it is obviously a matter of great importance in designing to secure a factor that is sufficiently high. In the design of a new projectile, the moments of inertia A and B and the spin N may be calculated, the latter from the twist of rifling and the muzzle velocity. The couple factor μ, however, can be computed only if the position of the center of pressure P and the magnitude N of the normal force are known. In the present state of mathematics it is not feasible to compute them theoretically, and resort must be had to experimental determinations.

DETERMINATION OF R, N, AND P

Suppose the designer of an 8-in. projectile has made a drawing of a new projectile and wishes to determine what range it will have when fired at a velocity of 2800 fps, and whether it will be initially stable or not when fired from a gun which has a twist of rifling of 1 turn in 30 calibers. To be able to compute the range and the stability factor, he needs to know R as a function of the density and velocity, N for the given muzzle velocity, and the position of P. It is in determining these relations that the model experiments performed at the Aberdeen Proving Ground of the Ordnance Department, U. S. Army, have been found so useful.

The method of determining R as a function of the velocity is in brief as follows: A model projectile of a shape similar to the proposed design is fired through a series of solenoid coils placed on a specially constructed 1000-ft range at intervals of 200 ft, as shown in the illustration on the first page of this article. As a result of the inherent magnetism from the earth's magnetic field, or from magnetism induced by artificial magnetization, when the fired projectile passes through a coil, a change in the magnetic flux is effected, as a result of which an electromotive force is induced in the coil. The coils are connected to a non-reactively coupled amplifier which is capable of amplifying all signals of audio frequency without appreciable distortion. The output of this amplifier is recorded by an oscillograph, timing lines also being placed on the film by means of an electrically driven tuning fork.[5]

A schematic drawing of the apparatus is shown in Fig. 3 and a sample of the records obtained in firing projectiles through two coils placed 8.04 ft apart is illustrated in Fig. 4.

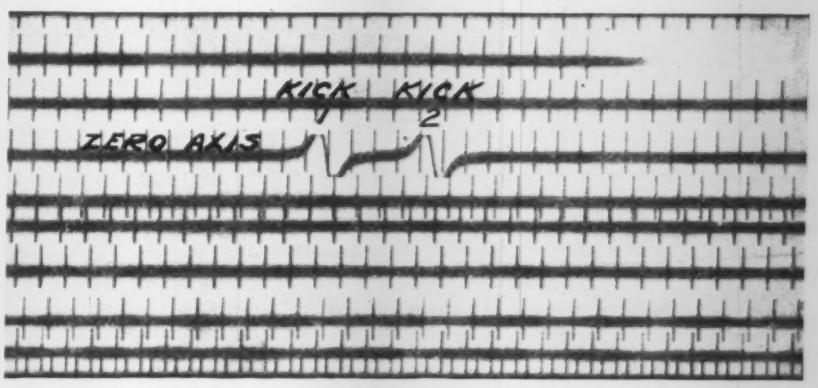

FIG. 4 AN OSCILLOGRAM RECORDING THE PASSAGE OF A MAGNETIZED 75-MM PROJECTILE THROUGH TWO COILS WHOSE CENTRAL PLANES ARE 8.04 FT APART

(The timing lines indicate thousandths of seconds. From this oscillogram, the velocity of the projectile was found to be 1738 fps.)

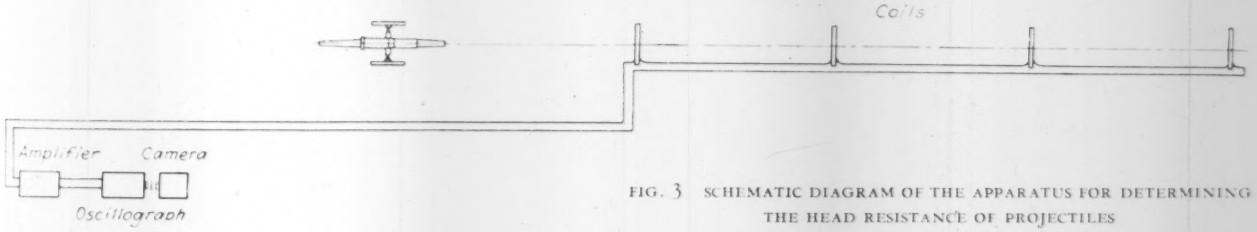

FIG. 3 SCHEMATIC DIAGRAM OF THE APPARATUS FOR DETERMINING THE HEAD RESISTANCE OF PROJECTILES

It is evident that if the oscillogram gives an undistorted record of the rise and fall of the emf in the coil, an accurate record of the time required to travel the distance between the two coils will be obtained since the point in the S-shaped "kick" where the light trace crosses the zero axis corresponds to the position of the shell when the flux through the coils is a maximum; in other words, when the S-kick crosses the zero axis, the magnetic center of the shell is in the central plane of the coil.

It is easy to see that from such a record the average velocity with which the shell traverses the distance between the two coils may be computed, provided the distance is known. In

[5] The first successful solenoid chronograph was developed by F. E. Smith of the British Admiralty during the latter part of the war. The development of the apparatus in use at the Proving Ground was begun by G. F. Hull and carried on afterward by E. A. Eckhardt. (See *Journal of the Franklin Institute*, July, 1922, pp. 49–67.) Further modifications of the apparatus have been made by the author. It is capable of measuring the time interval required for the projectile to pass between two coils with a probable error of approximately $^1/_{200,000}$ sec.

this way the average velocities at various points along the range are determined, and from the difference or drop in velocity the retardation due to the air resistance, and hence the air resistance (in poundals) itself, may be obtained.

For convenience in computation, to aid in applying the results to shell of dimensions differing from that of the model, and to allow for the effects of varying air densities, the results

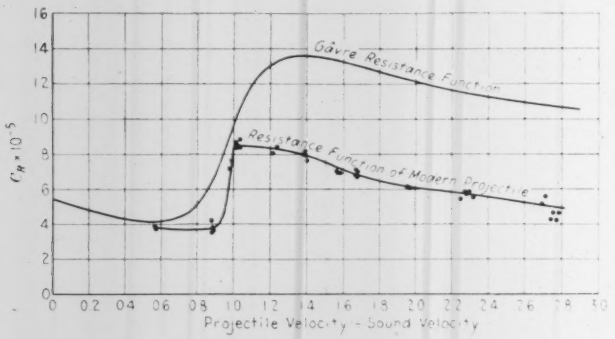
Gavre Resistance Function
Resistance Function of Modern Projectile
$C_R \times 10^5$
Projectile Velocity ÷ Sound Velocity

FIG. 5 RESISTANCE FUNCTION OF A BLUNT-NOSED FLAT-BASE PROJECTILE (THE GAVRE FUNCTION) AND OF A MODERN PROJECTILE WITH A LONG POINT AND A STREAMLINE BASE

[The Gavre function was obtained from firings by the French at Gavre in 1888. The resistance function of the modern projectile was obtained from firings at Aberdeen Proving Ground in 1922–1925. The discontinuity in the slope of the resistance function at the velocity of sound has been noted by Dupuis, Mem. de l'Art. Franc., vol. 7 (1928), p. 631.]

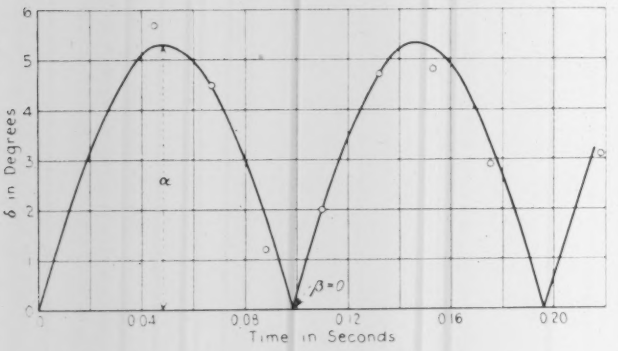

FIG. 6 δ-t CURVE FOR A 75-MM PROJECTILE

(The plotted points indicate the yaws as measured by means of cardboards placed along the trajectory.)

are tabulated in terms not of the resistance R itself, but in those of a resistance coefficient C_R, which is defined as follows:

$$C_R = \frac{R}{\rho d^2 v^2}$$

where ρ is the ratio of the air density to the normal air density, 1.204 grams per liter, d is the caliber of the shell in inches, and v the velocity in feet per second. The assumption is made that for a given shape of projectile C_R depends only on the ratio of the projectile air speed, v, to that of sound, a, and that it is independent of ρ and d. Strong support for this assumption is found in the theory of dimensions and also in experiment.

As a result of the firings through solenoids, the values of R at different velocities are computed as well as the values of C_R. C_R is plotted as a function of v/a as shown in Fig. 5, and for convenience the plot is called the resistance function.

As has been stated earlier, to compute the range of the proposed projectile it is necessary to know the resistance R as a function of the air density and velocity for the projectile. It is evident from the plot that the value of R for any air density and velocity may be computed from the relation $R = \rho d^2 v^2 C_R$, and thus the range of the proposed projectile may be computed.

A statement of the comparative results of measuring the actual range of a projectile and of computing the range from the resistance function should be of interest. The actual observed range of a certain 4.7-in. projectile at 45 deg elevation and a muzzle velocity of 2450 fps was found to be 20,200 yd. The range computed from the resistance function obtained by firing a similarly shaped 3.3-in. projectile through coils was found to be 19,900 yd, the difference being only 300 yd. While the agreement is not always as good as this, the closeness of the computed and the observed range is usually satisfactory.

As has been mentioned previously, in addition to information concerning R as a function of the density and velocity, it is necessary to know the value of the normal force N for the initial velocity of the projectile, and the position of the center of pressure. The procedure by which this important additional information is obtained will be set forth in what follows.

By means of the methods of theoretical mechanics, the equations of motion of the projectile[6] about its center of gravity may be integrated. In case it is assumed that the yaw is not damped, i.e., does not become smaller as the projectile moves along the trajectory, the expression for the angle of yaw δ as a function of the time t is found to be as follows:[7]

$$\delta^2 = \alpha^2 \sin^2 [0.5\Omega(1 - 1/s)^{1/2}t] + \beta^2 \cos^2 [0.5\Omega(1 - 1/s)^{1/2}t] \quad [1]$$

In this expression $\Omega = AN/B$, where, as before, A and B are the moments of inertia and N the spin, s is the stability factor, and α is the maximum and β the minimum yaw. The meaning of α and β may be seen from the curve in Fig. 6, which shows the yaw as computed by Equation [1], taking $\beta = 0$, and also a number of experimentally observed δ,t points. It is fair to attribute the discrepancy between the curve and the observed points to errors of measurement, but it is also partly due to the fact that the curve represents the undamped yaw—in other words, if the expression for the damped yaw had been used, the fit would obviously have been better.

From Equation [1] it may easily be seen that the period of the yaw T, i.e., the time from one minimum yaw to the next, is given by

$$T = \frac{2\pi}{\Omega(1 - 1/s)^{1/2}} \quad [2]$$

It is evident that if Ω and T are known, the value of s may be obtained from Equation [2]. In case the rate of drop in velocity is small, we may, without sensible error, write $l = v_0 t$, where l is the distance from the muzzle and v_0 the muzzle velocity. If L is the period of the yaw in feet, we thus obtain

$$L = \frac{2\pi v_0}{AN/B(1 - 1/s)^{1/2}}$$

Now the value of N, the spin, is $2\pi v_0/dn$, where d is the diameter of the bore in inches and n is the number of calibers

[6] See Fowler, Gallop, Lock, and Richmond, loc. cit., who have also treated in this article the motion when the yaw is small and damped.

[7] This expression is derived on the assumption that δ is small. It holds with a sufficient approximation for most practical purposes in case the yaw does not exceed 10 deg.

for one turn of the rifling. Substituting this value of N in the above equation,

$$L = \frac{nd}{12A/B(1 - 1/s)^{1/2}}$$

We are now in a position to explain the method by which the stability factor of a shell may be determined. Following the method developed by Fowler and his associates, the projectile is fired through a series of cardboards set up along the trajectory. The projectile cuts out holes, the major diameters of which vary with the yaw. A photograph of a number of cardboards with the holes cut by a projectile is shown in Fig. 7.

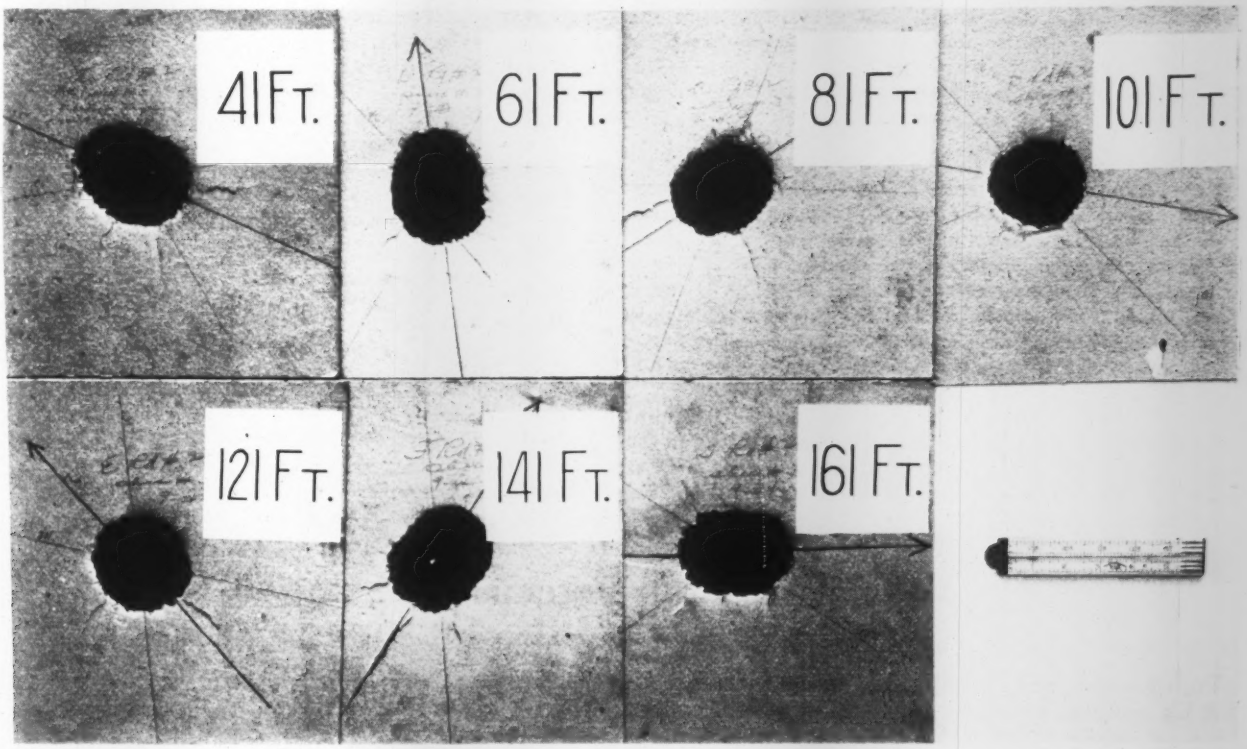

FIG. 7 PHOTOGRAPH OF YAW CARDS

(The angle of yaw is recorded by the length of the major axis of the hole, and the precession of the projectile is recorded by the angle that this axis makes with the vertical. The distances of the cardboards from the muzzle of the gun are indicated.)

From the length of the major axes of the holes, the amount of yaw of the projectile may be computed. The angle of yaw is then plotted as a function of the distance from the gun. The positions of the minima are thus determined and the period L is then found.

The value of s may then be computed from L and the known values A, B, d, and n. It was stated earlier that $s = A^2N^2/4B\mu$, hence μ is known when s is known.

It was seen on a previous page that the overturning couple M is equal to $\mu \sin \delta$, and that $M = (OP) \times N$, where N is the normal force. As it was assumed that M is proportional to $\sin \delta$, so it is assumed that N is proportional to $\sin \delta$ also; in other words,

$$N = \nu \sin \delta$$

where ν is called the normal force factor. From this it follows that

$$\mu = (OP)\nu$$

Thus far we have succeeded in determining the value of the product $\nu(OP)$, but it is desired to determine the value of each factor. The method by which this is done is as follows:

A projectile is fired with its center of gravity O_1 at a given position. From this the corresponding couple factor μ_1 is obtained, and

$$\mu_1 = (O_1P)\nu$$

Another projectile is then fired with its center of gravity at another point, O_2, and for this projectile there is obtained (see Fig. 8)

$$\mu_2 = (O_2P)\nu$$

Subtracting μ_2 from μ_1,

$$\mu_1 - \mu_2 = [(O_1P) - (O_2P)]\nu = (O_1O_2)\nu$$

The positions O_1 and O_2 are both known from measurements on the shell before firing, and thus it is found that

$$\nu = \frac{\mu_1 - \mu_2}{(O_1O_2)}$$

and the position P is determined by the relation

$$\mu_1 = (O_1P)\nu$$

The method by which the measurements obtained with the model projectile are applied to the calculation of the stability factor of the proposed projectile may now be described.

If the shape of the proposed projectile is similar to that of the model, then the centers of pressure of the two projectiles will be at homologous positions. In other words, if the center

of pressure of the model is h calibers from the base, the center of pressure of the proposed projectile will also be h calibers from its base.

For the purpose of calculating the value of ν for projectiles of varying dimensions, etc., a procedure similar to that employed in the case of the resistance R is followed. In other words, a normal force coefficient, C_ν, is defined as follows:

$$C_\nu = \frac{\nu}{\rho v^2 d^2}$$

and the value of C_ν is obtained from measurements on the model projectile. The assumption is then made that C_ν is independent of ρ and d, and is a function of v/a only. The value of ν for the proposed projectile at its proposed muzzle velocity is calculated from the relation

$$\nu = \rho d^2 v^2 C_\nu$$

The position of the center of gravity of the proposed projectile is calculated and the position of P, the center of pressure, is known. Thus the value of (OP) is known. The value of ν is obtained in the manner indicated, and thus $\mu = (OP)\nu$ may be obtained. The values of the moments of inertia A and B are calculated from the drawing, and the spin from the muzzle velocity and twist of rifling. In this way the stability factor for the proposed projectile when fired from the given gun is obtained.

The maximum range and the stability factor of the proposed projectile are calculated from the data obtained in the model experiments in the manner already described. If it is found that the range of the proposed projectile is suitably great and that its stability factor near the muzzle is sufficiently high, it may then be approved for manufacture with confidence that it will function in a satisfactory manner when actually fired.

Experimental investigations along the lines described have been carried on at Aberdeen Proving Ground during the last thirteen years by the staff—officers, enlisted men, and civilians—of the Proving Ground. The author desires to express his appreciation of the very effective support which the Ordnance Department has given to these programs.

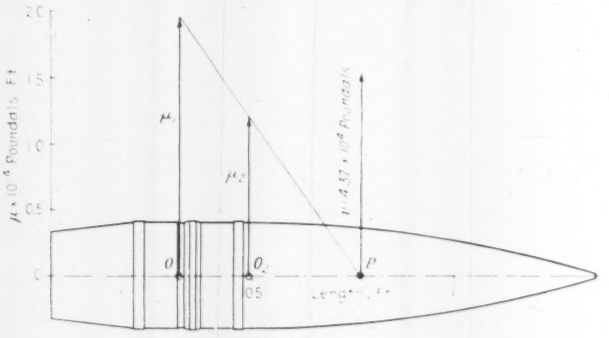

FIG. 8 PROJECTILE WITH COUPLE FACTORS FOR TWO DIFFERENT POSITIONS OF THE CENTER OF GRAVITY

(The center of pressure and the normal force factor as determined from these couple factors are also indicated. The projectile velocity producing these air forces was 2400 fps.)

What's Ahead in Foreman Training?

(*Continued from page 632*)

Probably there is no wholly satisfactory substitute for this hit-and-miss method. It is certain, however, that much improvement can be made through the intelligent use of rating plans and follow-up systems, and through the whole-hearted determination of the management to do a real job in appraising its human raw material.

A foreman should be selected with a view not only to his qualifications for the task immediately before him, but to his possibilities for further advancement. From the men who are appointed foremen this year, a company ought to be able to select its superintendents and plant managers ten or twenty years from now. Foremen should therefore be picked not merely for their technical knowledge of the job, but for their possibilities of developing managerial capacity. Only with the aid of this kind of selection for foremanship will training courses be able to function to the maximum of their possible usefulness.

In this connection it should not be overlooked that in the field of industrial education pre-foreman training is almost as important as the training of foremen. Some companies have secured valuable results by educational courses for the benefit of employees who were considered suitable material for promotion to supervisory positions. An extension of this kind of courses would be to the distinct interest of industry.

3 Managers should seek to acquire a more thorough understanding than most of them now have of the purposes of foreman training and the methods by which these purposes can best be accomplished. Too often in the past a particular type of training course was adopted simply because it had secured good results in another company or because it was presented to the manager by a clever salesman. Probably it is better to introduce foreman training in this way than not to introduce it at all, but certainly much time and money will be saved, and much lost motion avoided, if production managers and their educational advisers seriously study the merits of different types of foreman training in order to select those best suited to their own needs.

4 A better understanding of foreman-training methods by industrial managers is likely to lead, not to absolute uniformity, but to the elimination of some of the widest diversities, and to the development of methods which embody the best features of the courses now in use. Toward this integration educators and engineers can be of valuable assistance to industry.

5 As one means toward the early accomplishment of some of the improvements that have been discussed, a national association for foreman training might wisely be organized. Such an association would bring together the proponents of different types of foreman training for discussion, for the comparing of views, and for ultimate cooperation toward the advance of the whole movement.

INSPECTION OF SURFACES FOR MINUTE DEFECTS

By F. A. FIRESTONE,[1] Compiled by H. B. VINCENT[1]

THE importance of adequate final inspection in the manufacture of a quality product has led to the development of an automatic machine which is capable of inspecting the surface of an article with such close scrutiny that in polished or ground surfaces even fine cracks which are just visible to the eye can be detected and the pieces which contain them automatically thrown into the discard. The speed and cost of the inspection are about the same as with visual inspection, but the reliability is greater.

While the machine described below was designed for the inspection of ground cylindrical steel pieces for cracks, ingot breaks, burned spots, and spots not cleaned up, the utility of the principles involved is by no means confined to this field alone. Such a machine may be applied to the surface inspection of any kind of piece for defects which change the light reflectivity or transmissivity.

The general arrangement of the equipment is shown in Fig. 1. The product to be inspected is so mounted and moved

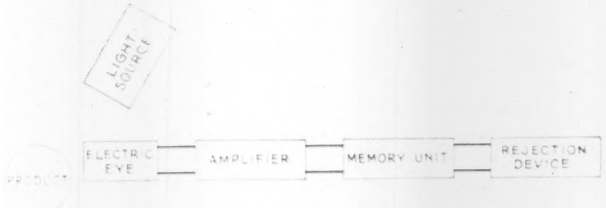

FIG. 1 GENERAL ARRANGEMENT OF EQUIPMENT

that during the process all parts of its surface lie at some time within the field of view of the "electric eye," while a suitable source of light furnishes illumination so that the eye may see and transmit its opinion of the quality of the surface to the memory unit. A vacuum-tube amplifier in the line increases the importance of this opinion, so that if the eye sees a bad spot, the memory is suitably impressed, and, lying in wait for the product at the termination of its inspection, it grasps it in its rejection device and consigns it to the scrap heap.

The essential details of the electric eye are shown in Fig. 2. A beam of light from an intense source passes through a set of condensing lenses and, falling on a smaller lens of high curvature, is further condensed to illuminate very brilliantly a small spot of the surface under inspection. A microscope objective lens, together with an eyepiece lens, forms a real image of this illuminated area on an opaque screen having a small aperture whose size determines the field of view of the apparatus. Light passing through the aperture falls on a photoelectric device which produces an electric current proportional to the illumination it receives, and if a portion of the surface having a reflecting power lower than the rest comes into the field of view, the current immediately drops in value. Inasmuch as a decrease in reflecting power indicates for most products a surface defect, the consequent decrease in current is made, after amplification, to operate the memory unit, and if the deficiency in reflection is more than a predetermined amount rejection follows.

The details of the memory unit are shown in Fig. 3. The unique feature of this part of the equipment consists in the use of a hot-cathode ionization tube containing a grid and a small pressure of some suitable gas. If a voltage exceeding the critical value is applied between the grid and the cathode, the gas in the tube is ionized, resulting in a very great increase in anode current. This current is easily sufficient to operate a simple rejection device such as a shutter or trap-door in a

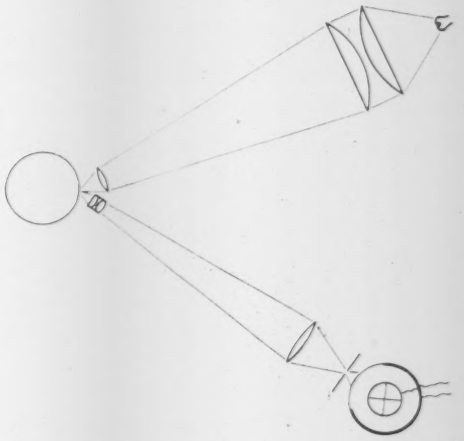

FIG. 2 DETAILS OF THE "ELECTRIC EYE"

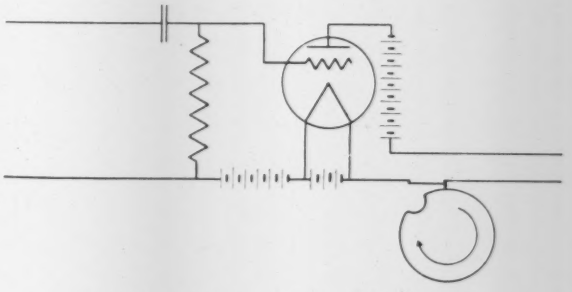

FIG. 3 DETAILS OF THE "MEMORY UNIT"

trough, down which the product slides on its way out of the machine.

When the inspection of an article is started, the final tube is in a de-ionized condition, and if the surface of the product is sufficiently uniform it remains so and the work is accepted. If, however, the electric eye sees a bad spot on the surface, it transmits to the amplifier an impulse of voltage which, after amplification, is sufficient to cause ionization in the final tube. The plate current of this tube remains automatically at its increased value and holds the rejection device open so long as the driving voltage is maintained. Thus the defect is remembered until the scanning of the surface is finished and the bad product is rejected. Before each inspection the plate circuit of the memory tube is opened for a short time by a cam switch or other suitable device and the ionization is stopped. This insures that the apparatus will approach each operation with an open mind and judge each product impartially.

The machine described was developed in the Department of Engineering Research of the University of Michigan.

[1] Department of Engineering Research, University of Michigan, Ann Arbor, Mich.

MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

Engineering Board of the R. F. C.

ENGINEERS everywhere will rejoice at the appointment of a board of engineers to advise the Reconstruction Finance Corporation in making loans to states, municipalities, and public agencies for self-liquidating public works. Not only will engineers approve and applaud the act itself, but also the spirit of cooperation that prevailed in selecting the personnel of the board. It is understood that the chairman of the board, the much-beloved professor-emeritus of civil engineering at Leland Stanford University, Charles D. Marx, honorary member and past-president of the A.S.C.E., representative of the western section of the country and specialist in municipal improvements, was President Hoover's own choice. The other members of the board were chosen from a list submitted by the American Engineering Council.

The mid-continent area is represented on the board by John Lyle Harrington, consulting engineer, of the firm of Harrington and Cortelyou, Kansas City, past-president of the A.S.M.E., and specialist in bridge design and construction. Another past-president of the A.S.C.E., John F. Coleman, consulting engineer, of New Orleans, who has a specialized knowledge of port development, represents, geographically, the South. Prof. John H. Gregory, of The Johns Hopkins University, long in consulting practice in water works and sewage disposal, represents the eastern section of the country and brings to the board his experience and knowledge of the field of sanitary engineering. The fifth civilian member of the board, Mr. Herbert G. Moulton, of New York, who is a consulting engineer specializing in reports for banking interests on railroad and mining operations and finance, was chosen largely for his knowledge of the financial aspects of engineering projects. Major-General Lytle Brown, Chief of Engineers, U. S. Army, an engineer of proved ability and wide experience in flood-control and other government engineering projects, is an ex-officio member of the board.

The wide experience and integrity of these outstanding engineers guarantee to the Reconstruction Finance Corporation a quality of service and professional advice that none can question. Behind the board stand the engineering profession of the United States and the organizations that represent it, conscious of the obligations that their special knowledge of construction place upon them, and eager to make the most of this extraordinary opportunity to serve their fellow-citizens.

Science Provides Problems for All

MARK well the following sentence, ponder its implications, and quote it to your pessimistic friends who fear the havoc wrought by science. "That any one of intelligence should seek artificially to shirk the problems presented by the things which science has introduced into our midst is tantamount to saying that the human mind which has been capable of extracting these new things out of Nature's storehouse of the unknown is incapable of adapting them to beneficent purposes."

Thus spoke Dr. Frank B. Jewett, of the Bell Telephone Laboratories, at the dedication of the Hall of Science of the Century of Progress Exposition, Chicago, Ill., June 1, 1932, as reported in *Science* on July 8.

We live in an age in which science and engineering are more inextricably woven into the fabric of every-day life than at any other time in the history of human progress. Even those who dwell relatively remote from towns and cities depend in immeasurable ways on the proper functioning of devices and services that were unknown to the generations antedating the industrial revolution. Our habitual environments possess an artificiality, in the sense that they are man made and man sustained, that necessitates the most intelligent cooperation of interrelated individuals and organizations. Except in the outposts of civilization, where exists the self-sufficient individual?

Elsewhere in his address Dr. Jewett confesses that, in common with most folk, he saw nothing very much of the social problems when, more than twenty years ago, he was "completely obsessed with the apparently illimitable field of opportunity offered to those who wished to make science a life work." But knowledge brings power, and power, responsibility. The toys of the laboratory change the lives of millions, and the direction and velocity of human progress.

The Centennial Exposition in Philadelphia in 1876 brought to the people of this country an awakening knowledge of the productive usefulness of machinery, and stimulated extraordinary developments in industry. The World's Columbian Exposition in Chicago in 1892 provoked interest and development in the field of electricity. Science is the keynote of the Century of Progress Exposition to be held next year in Chicago. Will its effect upon human progress be to bring to a majority of individuals a truer appreciation of the social aspects of science, a desire to make use of it for none but beneficent purposes, and a determination and courage to solve the problems that it places on Society?

Engineers' Council for Professional Development

LAST month on this page attention was directed to the formation of the Engineers' Council for Professional Development and an outline of the objectives of the organization was given. Elsewhere in this issue C. F. Hirshfeld, one of the representatives of The Ameri-

can Society of Mechanical Engineers on the newly formed Council, reviews the fundamental philosophy of this new undertaking. With the official backing of the A.S.C.E., the A.I.E.E., the S.P.E.E., the A.S.M.E., and the American Institute of Chemical Engineers already assured, and the probable early endorsement by the A.I.M.E. and the National Council of State Boards of Engineering Examiners, the success of the project is assured. It remains to arouse the enthusiastic interest and loyal support of individual members of these organizations and their local sections without which the potentialities of the Council cannot be developed to the fullest extent.

Engineers have nothing to lose and everything to gain by supporting this project and putting into it their best thought and untiring effort. Appreciation of the engineer and his place in society is growing rapidly. The profession as a fairly well-defined group of educated and competent men is assuming an important status in the estimation of laymen. Public confidence, already of a high order, rests upon the honorable and useful careers of individual practitioners. The appreciation, the esteem, and the confidence have been well merited and must be maintained. The profession faces obvious risks in not guarding them jealously by some properly organized agency such as the Council is intended to provide. The education and training of the engineer, his certification into the profession through self-instituted instrumentalities and in accordance with self-established and self-maintained standards, his continual betterment through his contacts within the professional societies, his obligations and responsibilities as an engineer, and his relations with the public, are proper interests for engineers.

The engineering profession will never be greater than its members make it. If they are satisfied to be mediocre and shallow citizens, their profession will be mediocre and shallow. But if they set high standards of attainment and attract to their profession men of superior natural ability and noble purpose, it and the public will be well served. The world has urgent need of the engineering type of mind with its intellectual honesty and its ability to stimulate purposeful and constructive action. All engineers should assist in furthering the projects for the benefit of society and the profession that the Council will develop.

Arrighi de Casanova

THERE has recently been issued an interesting and attractive brochure describing the new power station of Vitry-Sud in Paris. That gallant and beloved French soldier, d'Artagnan, whose exploits have offered vicarious adventure and heroic action to many an office-weary American, had for his family motto those significant words, "The end crowns all." The new power station of Vitry-Sud crowns the life work of Jean-Antoine Arrighi de Casanova, whose death, in April of this year, robbed the engineering profession of France and of the world of a great man and an exceptional engineer. On the motion of M. Mercier, the Board of Directors of the Union d'Electricité has named the Vitry-Sud station Arrighi, in honor of their former chief engineer, and with the desire that this action may stimulate younger generations of engineers to emulate the example set by this master builder.

Arrighi was well-known in this country and beloved by those who knew him. His engineering career in the Corps of Marine Engineers, which resulted from his brilliant record at the Ecole Polytechnique, led to his appointment, in 1916, when he was not yet 37 years of age, to the rank of Chief Engineer to the French Navy, and, in 1918, to the rank of Officer of the Legion of Honor. Withdrawing from the active list of the Navy in 1920, he was called by M. Ernest Mercier to fill the post of chief engineer of the Union d'Electricité, collaborating in the completion and extension of the Gennevilliers power station. A relentless disease cut short his career at the age of 53, not, however, before he had completed the great power station that now bears his name.

There is ample and honorable precedent for attaching to the work he directed the name of the engineer, as, for example, the Holland Tunnel. This is an appropriate and commendable practice. Back of every major engineering project there is generally to be found some individual whose genius and energy are embodied in it. While it would be bad taste for engineers to attach their own names to such projects, many a monument to engineering genius might appropriately be renamed at the death of its creator in commemoration of him and his services, and stand, as does the Arrighi station, a monument to a man and an inspiration to youth.

Julian Kennedy

IN 1928, The American Society of Mechanical Engineers did honor to Julian Kennedy, and to itself, by conferring its Gold Medal upon that master designer of steel plants. Julian Kennedy died on May 28, 1932. The record of accomplishments that he leaves behind him is an impressive one.

Born in Ohio in 1852, and graduating from the Sheffield Scientific School in 1875, Mr. Kennedy entered the steel industry after a brief experience as instructor in physics at his alma mater. As superintendent and engineer of numerous steel mills, Mr. Kennedy laid the foundations of a practical and intimate knowledge of the industry he served as a consulting engineer from 1890 on. In presenting him for the degree of Master of Arts at Yale University, in 1900, Prof. George P. Fisher said of him, "For the last ten years he has been connected as consulting engineer in almost every establishment of steel works in the United States, besides doing a great deal of engineering work in England, Germany, Austria, and Russia."

Julian Kennedy was a truly worthy successor of such men as John Fritz and Alexander Lyman Holley and carried on their splendid traditions.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

APPLIED MECHANICS

Mathematical Physics

IN DISCUSSING modern physics, an editorial in *Engineering* makes certain interesting remarks, of which the following two only are reproduced here.

It is comforting to note that engineers are not alone in finding the new physics unintelligible. M. Maurice de Broglie states quite frankly that fundamental laws can only be expressed in abstract terms defying all attempts at intelligible description. This remark occurs in a generous appreciation of the work of Lord Rutherford, which M. de Broglie contributed to a recent issue of *Nature*. In this he comments on the remarkable success with which Rutherford, avoiding all mathematical complications, has connected up the experimental facts by means of a theory which gives a direct visual picture of the phenomena in question. Only where this is possible can phenomena be regarded as intelligible, but in much modern work the general opinion seems to be that pictures are no longer practicable.

In his recently published lectures on "The New Conception of Matter," Prof. C. G. Darwin, F.R.S., a grandson of the great Charles, takes a less pessimistic view, and notes that more than a century ago the great discoveries of optical theory began life in mathematics. This statement perhaps does less than justice to Dr. Young, but it is true that the mathematical representation of the undulatory theory led to results which enabled successful predictions to be made, although the phenomena concerned could not always be represented by a model.

After discussing the nature of the electron, the writer makes certain general remarks as to the application of mathematics to science generally. The following is quoted:

How far mathematics represents reality is, however, another matter. It is probably true that the mathematical treatment of natural phenomena depends generally on the possibility of representing them by formulas which are continuous in form.

That such formulas do not necessarily coincide with reality may be readily illustrated. Thus, by Fourier's series we can represent a uniform load applied to a short length of a girder, and from this representation can deduce accurately the shear, bending moment, and deflection. The series, however, and the hypothetical uniform load are not identically equivalent. The original load curve and its representation have in fact quite different differential coefficients.

Nature undoubtedly seems everywhere to confront us with marked discontinuities. It was the German mathematician Krönecker who declared "God made the integers, all the rest is the work of man." It would seem to be inherently impossible to prove that the discontinuities observed are not real, though the mathematician has with extraordinary ingenuity and marvelous success been able to represent them by continuous formulas. It is permissible, therefore, to question whether Gamow's theory of the steady leakage of waves from the α particles in the nucleus of radium can be identified with reality, though the physicist who wishes to calculate and predict is fully justified in working on this assumption and would, in fact, be unwise in doing anything else.

As Sir J. J. Thomson remarked some years ago, a scientific theory is a policy, not a creed, and is useful so long as it works. (Editorial in *Engineering*, vol. 133, no. 3464, June 3, 1932, pp. 659–660, *g*)

BRIDGES

A Skew Bascule Bridge

THE demand for straight highway alignment that modern motor-car speeds have created has made skew bridges much more numerous than they once were. The present article describes an unusual type of such a bridge using a 66-deg angle of skew and erected between Trenton and Princeton at the crossing of U. S. Route 25 over the Delaware and Raritan Canal in New Jersey.

In selecting a type it was found that the estimates of cost were not greatly different for the single-leaf swing span, the vertical-lift, the double-leaf Bélidor bascule, or for the single-leaf simple trunnion bascule. The latter was finally selected for the reasons, first, that it could be built with the least interference to highway and canal traffic, and second, that it is probably the most satisfactory from the standpoint of the arrangement of its structural and mechanical parts. The original article tells in detail of the various stresses encountered in the bridge structure. With the counterweight located far to one side of the center of gravity of the span, torsional strains assumed paramount importance.

The scheme adopted which effected a saving in metal and at the same time eliminated most of the uncertainty regarding the distribution of the torsion, is described in the original article. By the framing adopted most of the torsion on the rotating unit is imposed upon the reinforced concrete of the counterweight. (Wm. Guy Williams, formerly associate engineer, Waddell and Hardesty, New York, in *Engineering News-Record*, vol. 108, no. 22, June 2, 1932, pp. 791–794, 5 figs., *d*)

ENGINEERING MATERIALS

Asbestos Textiles

THE grade or quality of asbestos yarn is determined by the mixture of a certain quantity of vegetable fiber, usually cotton, with the asbestos. The asbestos roving delivered by the card is spun into yarn by two methods—mule and ring—both producing yarn by the same principle, that is, by twisting the soft roving on its own axis, thereby binding the fibrous mass into a more compact thread, where formerly it had but little cohesive strength. In the main, mule spinning is used to produce a softer, more pliable single yarn to be later twisted into a ply yarn, while ring spinning is used to produce a harder-twisted, stronger yarn which can be used in the single on braiders and winders in packing and in weaving of fine cloths and tapes.

Asbestos yarns and roving are produced and sold by size or cut and not by diameter. The size or cut of the yarn means the number of 100 yd to the pound of the single- or one-ply yarn. Thus a 10-cut yarn or roving will average 1000 yd per lb. Although asbestos has been spun into yarns as fine as 70's, the commercial sizes run from 8's to 20's as there is very little call for the higher counts. With a few exceptions the count or cut jumps 200 yd at a time, as, for example, 8's, 10's, and 12's, because asbestos yarn, owing to its mineral raw material, is recognized as varying considerably in yardage. Tolerances of 14's and finer are accepted as being ± 100 yd from the count, and ± 50 yd for lower counts. It would therefore be rather difficult to determine intermediate cuts or counts as their yardages would at times overlap.

The five generally recognized qualities or grades of asbestos yarns are outlined in the Society's proposed revised Specifications for Tolerances and Test Methods for Asbestos Yarn (D 299-29) as follows: Grade A-1, a minimum of 77 per cent asbestos; grade A, 80 to 85 per cent; grade AA, 90 to 92 per cent; grade AAA, 95 to 96 per cent; and grade AAAA, all asbestos, with a trace (usually about 1 per cent) of foreign matter permitted. These grades are the result of years of experience in producing asbestos textiles to meet all requirements of industry as cheaply as possible, and in addition to covering all necessary qualities, enable the manufacturers to utilize in the lowest grades a part of the waste produced in the higher grades. The grade or quality of a wire-inserted asbestos yarn is determined by the grade of the asbestos strands in the yarn, no account whatever being taken of the wire.

Asbestos is commonly called fireproof, but a better term would be "fire resistant." A sufficiently high temperature can eventually destroy almost everything known, and asbestos is no exception. The breakdown of asbestos under heat depends entirely upon the loss of its water of hydration, of which chrysolite asbestos has an average of 14 per cent. The water of hydration begins to leave asbestos just above 600 F (315 C), but only at a very slow rate. At 1000 F (540 C) about one-fourth of it has been driven off, but at this point it begins to go more rapidly so that above 1200 F (650 C) it will quickly disappear entirely. After the water of hydration has been driven off the fiber becomes completely calcined and can be crushed to a powder. The length of time during which the fiber is subjected to a given temperature has very little effect, the temperature itself being the important factor.

Asbestos has also been called an insulator against heat. This is also slightly erroneous. Asbestos in solid form is not an insulator but will transmit heat. When woven into a fabric its insulating qualities are almost negligible if applied directly to the source of heat. As an example, a piece of asbestos cloth laid on a metal plate having a temperature of 900 F (480 C) reduced the temperature above the cloth only 35 F (19 C). However, asbestos in cloth or other forms does furnish a strong heat-resisting medium around which insulation in the form of enclosed air spaces, for instance, can be built.

In order to give the reader some idea of the temperatures which the various grades of asbestos textiles will safely stand, the following may be stated as a general rule: Grade A-1 and grade A, 350 to 400 F (175 to 205 C); grade AA, 600 F (315 C); grade AAA, 850 F (455 C); and grade AAAA, 950 F (510 C). These figures must be considered as applying to plain asbestos yarns and cloths without impregnation, coating, or treatment of any kind. Special severe conditions may reduce these limits, and conversely, ideal conditions of service may greatly increase them. (C. K. Dillingham in a paper before the Annual Meeting of the *American Society for Testing Materials*, Atlantic City, June 20-24, 1932, abstracted from preprint, no. 78, 7 pp., *dp*)

FOUNDRY

High-Pressure Die Castings

THE Schultz Die Casting Co., Toledo, Ohio, makes zinc-base die castings by forcing metal into the molds at high pressure and maintaining a uniform and low melting temperature. It is said that castings are being made that are held within limits of plus or minus 0.001 in. or a fraction thereof. The company is manufacturing thin-section castings which it is producing in thicknesses of $^1/_{32}$ in. In an endeavor to learn what could be accomplished in making castings in still thinner sections it has succeeded in producing small castings with a wall thickness of only 0.017 in.

The metal used is a zinc-base alloy containing 4.10 per cent aluminum, 2.70 per cent copper, and 0.03 per cent magnesium. This is a product made by the New Jersey Zinc Company.

With low casting temperature the company claims to have succeeded in improving the structure of the metal and in securing more uniform product and closer dimensional accuracy, the latter being due to a reduction in shrinkage. Casting at low temperature also tends to retain in the metal its original qualities, some of which might have been destroyed by melting at higher temperature.

The use of high pressure permits the making of thin-section castings at comparatively low casting temperatures. Other practices include holding dies to close accuracy and keeping the metal clean by having covers over the melting pots to exclude the air, and thus to a large extent reducing oxidation. Consequently, there is very little if any dross. By following the production methods outlined, castings are being produced that are said to be free from blowholes and have few pinholes. Castings have been made with as high a tensile strength as 55,000 lb per sq in., although the usual range is from 47,500 to 50,000 lb.

The die-casting machines are hand-operated by one man. It is stated that production is practically as rapid on this type of machine as on an automatic machine, and that it has an advantage over the automatic type in that the operator is always kept close to the machine and can watch operations. (F. L. Prentiss in *The Iron Age*, vol. 129, no. 23, June 9, 1932, pp. 1246-1247, 1 fig., *d*)

FUELS AND FIRING

Continuous Gas Carburizing

THIS is a description of the eutectrol process for continuous gas carburizing as developed by the Surface Combustion Corporation of Toledo, Ohio.

The details of this process may be summarized as follows: A hydrocarbon gas which contains from 8 to 10 per cent carbon dioxide is mixed with the products of combustion of a gas-fired furnace. These mixed gases are introduced into a muffle containing work to be carburized in such a manner that they will flow through the muffle in the same direction as the work. The work is then moved progressively through successive temperature zones of the furnace. The hydrocarbon gas begins to break down into its constituents of hydrogen and carbon in the pre-heat zone, so that the work to be carburized soon becomes covered with a deposit of carbon. The deposition of this carbon is regulated carefully so that it is made to occur on the surface of metal to be carburized, rather than on the walls of the muffle through which it is passed. The presence of flue gas in this first zone of the furnace serves as a desirable diluent for the rich carburizing gas.

As the work, now covered with carbon, moves along through the furnace it comes into the high-temperature zone in which the CO_2 of the flue gas becomes active. In this zone CO_2 reacts with carbon to form CO, in accordance with the chemical reaction: $C + CO_2 = 2CO$. This means that carbon monoxide, which is known to be an active carburizing gas, is being formed progressively at the metal surface directly in contact with the metal to be carburized.

It is important to note that in this zone there is always present, along with the carbon monoxide, a certain amount of hydrocarbon gas that has not broken down completely. The presence of this gas prevents decarburization of the metal in the high hydrogen atmosphere in this case. By holding this metal in such an atmosphere a progressive diffusion is brought about between the case and the core, necessary for satisfactory carburizing.

The general design of the furnace is shown in the original article. It comprises a muffle chamber expanding throughout the furnace length, ending at the charging end in a purging chamber and at the discharging end in a cooling chamber which may act if desired as a holding chamber. The furnace is heated by gas burners firing above and below the muffle with proper control of temperature.

The rate of carburizing attained by this method is shown by the fact that a case penetration of 0.045 in. can be obtained in three hours at a temperature of 1675 F with S.A.E. 2315 steel. This is about three times the usual rate in pack carburizing. (H. M. Heyn, Sales Engr., Surface Combustion Corporation, Toledo, Ohio, in *Steel*, vol. 90, no. 26, June 27, 1932, pp. 23-25, 4 figs., *d*)

Colloidal Fuels for Marine Service

THE Cunard steamship *Scythia* left Liverpool for New York on June 11 with 150 tons of a new colloidal fuel which is to be burned under one of her six main boilers. This fuel is a mixture of 60 per cent fuel oil with 40 per cent pulverized coal. Laboratory tests have shown that the mixture remains stable under ordinary conditions. The results of the first voyage have not yet been announced.

The principle of the colloidal fuel is not new, as in 1919 a mixture of coal and oil with a material to hold it stable, called "fixateur," was devised by Lindon W. Bates, chairman of the American Submarine Defense Association. (Item in A Seven-Day Journal of *The Engineer*, vol. 153, no. 3988, June 17, 1932, pp. 655, *g*)

INTERNAL-COMBUSTION ENGINEERING

Metering and Injection in High-Speed Diesels

THIS article deals particularly with Diesel engines intended for driving buses, trucks, and automobiles. Elaborate attempts have been made to correct the lack of flexibility of the engines, mainly on the assumption that the root of the trouble lies in the varying rate at which work is done in compressing the air in the cylinders at various speeds. The point is made that at low revolutions the rate of work done on the air is lower, and the final compression pressure and temperature for a given apparent compression ratio are not high enough to insure cold starting and satisfactory ignition of the oil at the low speeds. Further, it is said that an increase in calculated compression ratio, while correcting the starting and low-speed conditions, would so increase the maximum pressures and temperatures at full-load speeds that the engine would have to be constructed much more robustly to withstand them.

An engine supplied to correct this condition is shown in Fig. 1 of the original article. The exhaust ports are provided with what might be called a secondary exhaust valve automatically varied as to timing so that at low revolutions it closes, say, at bottom piston dead center, in which case compression would start at bottom dead center. When the speed increases toward full-load values, closing of this valve is more and more delayed, thus decreasing the volume of air compressed, with the result that at a full-load speed compression may not actually start until the exhaust ports are re-covered by the piston.

Compression trouble, however, is not the sole cause of "sputtery" operation at low speed. The author considers next low-speed operation from the standpoint of solid injection, and discusses both the penetration and the turbulence methods of burning the atomized oil. In either method the oil spray must not come into contact with the metal of the combustion chamber as it sticks to it and carbonizes upon the metal. Turbulence is not as vital in the Diesel as in the gasoline-type engine, because the flame rate in the latter is entirely dependent upon a mechanical carriage through the whole mass of gas of the ignited mass adjacent to the spark-plug points. In the Diesel, turbulence should be regarded simply as a means of bringing air to the oil, which, of course, has its effect on rapidity of combustion, but for reasons different from those found in the explosive-vapor engine.

According to the author, the key to the problem is varying fuel-pump speeds accompanied by varying spray velocities, resulting in varying degrees of pulverization efficiency. This in turn causes varying combustion efficiency, with consequent variation in the working pressures developed. The rapid decrease in Diesel thermal efficiencies at lower loads is a further result of poor atomization, with its train of evil effects on the engine generally.

On account of injection timing requirements, fuel-measuring pumps, such as the Bosch pump, are all driven direct from the engine, so that as the engine speed varies, so also does the plunger-travel velocity in the fuel pumps.

As pulverization is produced simply by the rate at which oil is forced through the spray-nozzle holes, pulverization naturally suffers as the engine revolutions drop, soon reaching a value where the oil particles are too large for rapid, complete combustion. The author has heard two-cycle engines condemned on account of irregular firing at high speeds, supposedly due to the short period of time for exhausting and recharging the cylinders, yet just as erratic firing was encountered at the lowest speeds, at which the explanation would no longer hold. Further, with an increase in supercharging pressure at the lowest speed in these engines, no appreciable improvement was shown in firing regularity or perfection of combustion. In one case arrangements were made to control spray-nozzle velocities artificially, with immediate improvement of firing regularity, combustion, and horsepower output at low revolutions. An injector velocity increase throughout the entire speed range resulted in marked improvement and an almost total elimination of after-burning.

Another noteworthy point against the present spring-opposed needle-valve types of injectors is the chattering action found in the oil-pressure diagrams taken from the body of the valve. The oil may be at maximum pressure just prior to the opening of the needle, but the moment the needle moves off its seat there is an immediate lowering of pressure due to the displacement change that occurs in the valve body. For a fraction of a second high pressure and high velocity may exist. Both immediately fall, however, due to removal of displacement resulting from the needle withdrawal from its seat. The needle valve consequently bounces back on to its seat, thereby

cutting off the fuel injection momentarily until the fuel-measuring pump brings the oil pressure in the valve body high enough to lift the needle once more. This, again, is immediately followed by lost displacement and another bounce of the needle on to its seat. Thus, although the fuel-pump cam drive may be of such a contour as to produce theoretically uniform plunger velocity throughout the working range of injection, the actual injection itself takes the form of a series of pulsations of greatly varying velocity, with a low mean velocity. It is therefore not to be expected that the spring-loaded needle-type injector used almost exclusively today in solid-injection engines, will have firing conditions conducive to the regular firing in Diesel engines that is obtained in gasoline engines. The subject still requires a great deal more research. With constant-velocity spraying throughout the entire period of each injection, maintained throughout the active speed range, there is promise of just as good flexibility with Diesel engines as in the gasoline engine. (Alan Craigon, in *Power*, vol. 75, no. 25, June 21, 1932, pp. 921-923, 3 fig., *dt*)

MACHINE-SHOP PRACTICE

Automatic Loader for Machine Group Performing Turning Operations

ONE operator with the loader now made by the Seneca Falls Machine Co., of Seneca Falls, N. Y., does the work which covers preparing the pieces to be machined and placing them on a conveyor. The pieces are taken automatically one by one from that point on, from one machine to the other, until they are delivered to a chute on the other side of the bank of machines. In this way several machines may perform a sequence of operations without the use of manual labor.

The group of machines to which the loader has been applied comprises an automatic centering machine made by the use of two Kingsbury heads, and two standard Model U automatic Lo-swing lathes. The machines operate as any standard machines would. After the machining has been completed the carriages return to the starting position and the spindles stop. It is at this point that the automatic loading arrangement is thrown in by switches placed on the machines. The sequence of operations is as follows:

1 The fingers are lowered and grip the work
2 The tailstock spindles are withdrawn
3 Fingers lift the work
4 Heads carrying the fingers traverse to the right to positive stops, which locate each individual head in respect to the machine it is serving
5 Work is lowered into the machines
6 Tailstock spindle advances, holding work on centers
7 Fingers open
8 Fingers are lifted
9 When the head is clear, machines are started
10 Heads traverse to the left ready to repeat cycle as outlined.

The various movements of the loading mechanism are obtained hydraulically, while the control is obtained through electric switches which operate solenoid valves. On a job described in the original article (an automobile steering-sector shaft), one operator snags, cuts to length, centers, and rough and finish turns 93 pieces an hour. The production per day is said to be greater because the machines operate continually and operator fatigue does not affect the production. (*The Iron Age*, vol. 129, no. 22, June 2, 1932, p. 1210, *d*)

MARINE ENGINEERING (See Fuels and Firing: Colloidal Fuels for Marine Service)

Automatic Stabilization of Ships

IN THE course of a review of a book by T. W. Chalmers under the above title, the reviewer states that Chalmers discussed the effect of rolling and pitching on the structural strength of the vessel and suggests that the effect of the former is more severe. He also attempts to refute the idea that control by stabilization does not increase the structural stresses. The reviewer states that many will disagree with these views, for it is seldom that one learns of damages from transverse racking, whereas damage to the longitudinal structure is of every-day occurrence. Chalmers indicates that with stabilization the vessel will not lie to the angle of the wave upon which she is poised. In the opinion of the reviewer, this means that there would be an excessive buoyancy on one side and a deficiency on the other, and these might set up severe racking stresses. The reviewer advises that a new type of anti-rolling tank has been patented in Germany. The principle employed is to pump water to the high side of the vessel during its off period. (*Engineering*, vol. 133, no. 3464, June 3, 1932, p. 650, *g*)

MOTOR-CAR ENGINEERING

An Auto Stopping-Distance Table

ACCORDING to the data compiled by the Pennsylvania Highway Department, the following are the safe margins between vehicles traveling in a single lane at various speeds: Thirty miles an hour, 71 ft; 35 miles, 90 ft; 40 miles, 113 ft; 45 miles, 138 ft; 50 miles, 167 ft; 55 miles, 198 ft; and 60 miles, 233 ft. (American Road Builders' Association, typewritten release, 2 pp., *p*. These figures differ considerably from those given by John Younger in a paper in *Bulletin of the S.A.E.*, Jan., 1917, p. 369, entitled "Retardation of the Automobile." It should be remembered, however, that Younger's tests were made with hard tires, while the present figures refer to cars equipped with balloon tires.—EDITOR.)

The Costs of Motor Speeding

THE *Hercules Record* for April-May, 1932, states that the Chicago Motor Club made some investigations about the relative consumption of oil, gas, and tires at high speeds as against relatively low speeds with the following results: Oil consumption at 55 mph is seven times greater than it is at 30 mph. Tire wear at 50 is twice as much as at 40 mph. Gasoline consumption at 55 is one-fourth more than at 30 mph. No estimate is made of the increased wear and tear on the car at the higher speeds. (Abstracted through *National Safety Council News Letter*, Metal Section, June, 1932, *g*)

POWER-PLANT ENGINEERING

The Cooling of Superheated Steam

THIS may be needed where either the engines and apparatus that are to use the steam cannot handle it with the amount of superheat produced, or where the steam is to be used at lower temperatures for purposes of cooking in chemical industries. The matter of cooling the steam must be handled simultaneously with that of maintenance of the desired temperature, which latter is needed in power generation to insure the best performance of the prime movers and in chemical industries to maintain the

quality of the product. Among the fields of application of superheated-steam cooling, reference is made to prime movers. Here peak loads are apt to produce great variations in the temperature of the superheated steam which, in the first place, affect the efficiency of the machine, be it a reciprocating engine or a turbine, and next, because of the change in temperature, produce variations in thermal expansion of the engine, which again may cause trouble. Steam cooling with proper governing makes it possible to maintain the temperature of the superheated steam independently of any other variations, and thus operate the engine or turbine all of the time at the best efficiency.

APPLICATIONS OF STEAM COOLING

In the cellulose and paper industry, coolers may be used both for power generation and cooking. In the latter case it is

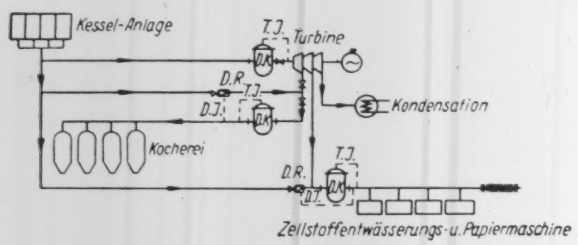

FIG. 1 DIAGRAMMATIC SKETCH OF STEAM-COOLING INSTALLATION IN CELLULOSE AND PAPER MILLS

important in order to maintain the highest permissible temperature, for this makes possible economies not only in steam but also in the cooking lye. In paper machinery the installation of a steam cooler improves the output of the driers and the quality of the product. Fig. 1 shows how steam coolers can be installed in the cellulose and paper industries. Here *DK* is the steam cooler; *DR* the pressure regulator; *TI*, temperature impulse; and *DI*, pressure impulse; *Kessel-anlage* means boiler plant; while the bottom line in German reads "dehydration of cellulose and paper machine."

An important application of steam cooling is that of removing oil from the exhaust steam. It is very difficult to get rid of oil carried over by superheated exhaust steam, but if the steam is allowed to become wet it is then easy. The removal of oil from steam may be very important where the latter is used for cooking in chemical processes.

It was believed initially that the problem of cooling superheated steam was simple, and that all that was necessary was to inject into the steam a certain amount of atomized water. It was found out, at an early date however, that the droplets of water do not atomize by themselves, due to the fact that superheated steam is very sluggish in giving up its heat. What happened was that the minute droplets of water in the steam were carried over with the latter to the engine or turbine. With the velocities of steam now used the droplets travel from 30 to 50 meters (98 to 164 ft) a second, and numerous tests have shown that such a short period is entirely inadequate to provide complete vaporization of the water mist. It is true that thermometers in the stream of steam showed the desired temperature, but this did not mean that the required degree of cooling of steam actually took place. The misleading readings of the thermometers were due to the fact that the latter were alternately covered by water droplets and superheated steam, and therefore gave an average reading which did not indicate the temperature of the steam alone. An attempt was then made to install a mixer at a point some meters back of the water injection. The only result of this was that a large proportion of the cooling water previously injected separated out of the mixer, and in consequence a very large excess of water had to be used. This excess of water had then to be brought up to the prevailing pressure and heated to the temperature of saturation, which all was quite unnecessary as the water was permitted to escape from the mixer with all the heat that it contained. Moreover, the steam did not give evidence of uniform cooling.

NARROW PASSAGES IMPROVE OPERATION

A step in advance was made when the mixture of steam and water, after the injection of the latter, was forced to flow through narrow passages. Perforated screens or other devices were used to produce an intimate mixing of the two fluids and a rapid evaporation of the water. This arrangement, however, entailed an important disadvantage in that the slightest mechanical impurities or scale-forming substances accumulated in the narrow passages, and even when apparently the cleanest feedwater was used, soon produced a pressure interference which caused trouble in the operation of the steam machinery.

All the work described above led to the conclusion that the cooling of superheated steam by injection of water was not practicable. This led to experiments with all kinds of surface coolers. With this type of cooler the evaporation or heating of the cooling water takes place on a surface on which the impurities are free to settle. On the other hand, however, surface coolers are very expensive, and their first cost bears no proper relation to their usefulness. This is particularly so in cases where the cooling must be carried from a very high initial temperature to approximately the temperature of saturation.

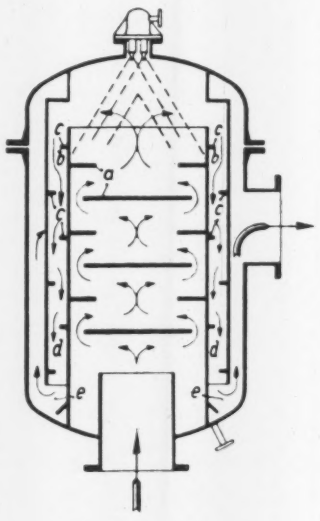

FIG. 2 THE FRAMBS AND FREUDENBURG SUPERHEATED-STEAM COOLER

The heating surface of these surface coolers consists in the majority of cases of small pipes, and in order not to have their efficiency reduced too much these pipes must be cleaned fairly often, which causes undesirable interruption of operation. Furthermore, care must be taken to keep the numerous joints tight, for if any of them have to be repaired the operation of the plant is interrupted, while if they are allowed to leak, cooling water gets into the steam and causes trouble in the machine where the latter is used.

Another serious disadvantage of surface coolers lies in the difficulty of obtaining a close regulation of temperature. Because of the large amount of metal and considerable water content, the cooler is too sluggish in action to follow easily variations of conditions of operation.

Fig. 2 shows a combined injection and surface cooler. It is said that the disadvantages of the two types have been largely eliminated in this design. The evaporating surfaces *a* are heated by the superheated steam, which loses thereby a certain share of its heat. The tops of these surfaces are moistened by a thin film of water, causing an intensive evaporation. The

steam thus generated mixes easily with the rising main flow of steam, particularly as care is taken to produce immediately a certain amount of turbulence. Additional mixing is provided through steam flowing downward through the passage *b* in contact with surface *c*. At *d* the steam is completely dry, and what is particularly important, thoroughly well mixed. It has, however, to pass through a water separator *e*. Here the finest particles of water are precipitated because of the abrupt change in direction (about 180 deg) of the steam flow. This water separator is really entirely superfluous, but has been provided because in hand regulation an excessive amount of water may be admitted to the cooler by a careless attendant. Where auto-

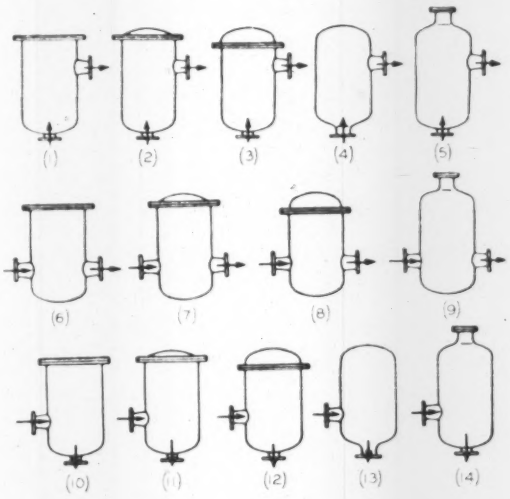

FIG. 3 VARIOUS ARRARGEMENTS OF STEAM COOLERS

matic regulation is employed, the water separator comes into action only when for some reason or other the governor gets out of order.

The evaporating surfaces *a* are of generous proportions, and the use of excessive amounts of water is here not as harmful as would appear at first sight. For example, should it be desired to cool 10 tons of steam from 400 to 300 C (752 to 572 F) at a pressure of 10 atm abs, 812 kg (1780 lb) of water at 100 C (212 F) will be required. Should, through carelessness, more water than necessary be admitted, the temperature of the steam will fall below 300 C. But it is only when the amount of cooling water is increased to about 2100 kg (4630 lb), per hr that is, to an amount 2.6 times what is necessary, that the critical point is exceeded.

The cooler designs may take the forms (1), (6), and (10), Fig. 3, for low pressures and small diameters; (2), (7), and (11) for higher pressures and small diameters; (3), (8), and (12), for higher pressures and larger diameters; (4) and (13) for high pressures and large diameters; and (5), (9), and (14) for the highest pressures and medium diameters.

Automatic Regulation of Steam Coolers. It is quite rarely that hand regulation of steam coolers is employed, and as a rule automatic regulation of the supply of cooling water is preferred. Such a regulator consists of a sensitive member built into the line carrying the cooled steam, and of a cooling-water valve controlled by this sensitive member.

Nowadays indirectly operated regulators are preferred because of their great reliability; this applies particularly to hydraulic regulators, water or oil operated; oil provides higher reliability of operation, as the same oil, properly cleaned, can be used over and over, and thereby danger of clogging of apparatus by dirt is avoided. It is recommended that the regulator valve be equipped with a bypass, permitting the device to be operated by hand should the automatic governing fail. The arrangement of such a governor is shown in Fig. 4. The injection nozzles are located in the nozzle at *a*, each nozzle provided with a return valve the purpose of which is to prevent back flow of steam into the cooling-water pipe *b*. Each nozzle can be shut off independently of all the other nozzles. As a rule three nozzles are used, two being sufficient for ordinary conditions of operation and the third constituting a reserve. The nozzles can also be operated by means of the hand valve *c*.

It is recommended that the admission and exit temperatures of the steam be measured either by means of the mercury thermometer *d* or by the distant-reading thermometer *e*. Fig. 4 shows an electric distant indicator so arranged that it can read either the inlet or the outlet temperature. Where particular danger is involved, various additional safety devices may be used. Thus, for example, the author recommends the installation of a reserve oil pump, driven not by an electric motor but by a small turbine. Temperature observation may be supplemented by optical or acoustical signaling or distant recording. In order to produce really good cooling the cooling

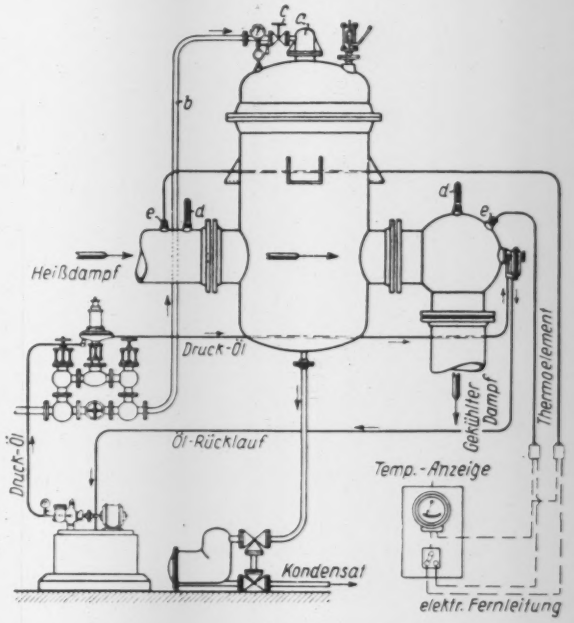

FIG. 4 AUTOMATIC GOVERNING OF WATER SUPPLY IN A STEAM COOLER

(*Heissdampf*, superheated steam; *druck-ol*, pressure oil; *ol-rücklauf*, oil return line; *kondensat*, condensate; *gekühlter dampf*, cooled steam; *temp. anzeige*, temperature indicator; *elektr. Fernleitung*, electrical long-distance temperature-reading device.)

water must possess a pressure at least 2 atm above the steam pressure prevailing in the coolers. In the majority of cases the pressure in the boiler feedwater pipe is sufficient, and water can be taken therefrom. Where this cannot be done a separate cooling-water pump must be installed, and it is recommended in such a case that the pump be equipped with a separate governor controlling the cooling-water pressure. An illustration of such an installation is shown in the original article, where results are given describing several examples of installations for steam cooling. (B. Müller in *Die Warme*, vol. 55, no. 20, May 14, 1932, pp. 331–335, 21 figs., *dp*)

RAILROAD ENGINEERING

Freight-Delivery Time

THE L. M. S. Railway reports that a recent one-day census of all general-merchandise traffic handled by the company shows that in the case of over 100,000 consignments conveyed by freight train, 92 per cent were actually in the possession of the consignees on the second day after being handed to the L. M. S. In the case of consignments passing to the larger towns, no less than 89.5 per cent were in the hands of the consignees on the day after dispatch. Having regard to the fact that the L. M. S. is dealing by freight train with consignments totaling over 100,000,000 per annum, the average weight of which is not over 500 lb, and that the ramifications of the system extend from Wick to Thurso in the north to London in the south and Bristol and Bournemouth in the west, the results of this "one-day census" are claimed to show a remarkable degree of freight-service efficiency. (*The Engineer*, vol. 153, no. 3987, June 10, 1932, p. 629, *g*)

REFRIGERATION

Vacuum Refrigeration

A VACUUM-refrigeration system for maintaining water at low temperatures has been developed, and can be installed wherever there is a supply of steam for operating the equipment. The operating principle of this system is flash evaporation. The water to be cooled is piped into a chamber in which a high vacuum is maintained. It is obvious that, if the water delivered to the vacuum chamber is warm and the vacuum is high, the reduction in absolute pressure of the water will cause the water to boil, evaporating a portion of it. Vapor which is liberated from the body of the water absorbs latent heat of vaporization from the liquid introduced into the flash chamber. Abstraction of this heat cools the remaining water to a temperature which corresponds to the absolute pressure in the flash chamber.

A numerical example is given to illustrate the principle of flash evaporation. In order to produce very low absolute pressures a steam-operated thermo-compressor is used. This consists essentially of a group of high-efficiency steam nozzles directed toward an entraining throat. Arrangement of the complete equipment is shown by Fig. 5. The thermo-compressor suction connects directly to a flash chamber and discharges directly into a high-vacuum condenser which, in turn, is served by a small two-stage steam-jet air pump. Two tail pumps are provided, one for removing the cooled water from the flash chamber and one for removing the condensing water from the condenser. If it is assumed that the normal supply of condensing water is at a temperature not exceeding 80 F, it would be possible to maintain within the condenser a vacuum corresponding to an absolute pressure of 2 in. of mercury. Under the conditions assumed in the example, the duty of the thermo-compressor would be to remove 19.1 cu ft of water vapor from the flash chamber for each pound of water introduced therein and to compress this vapor to an absolute pressure of 2 in. of mercury within the condenser. At this pressure the vapor could be condensed by the 80-F condensing water.

In this method cooled water is refrigerated directly without the necessity of an intermediate refractory medium such as ammonia or sulphur dioxide. The apparatus works under a vacuum as it is not subject to the danger of explosion. The only moving parts are the rotors of the two centrifugal pumps. (D. K. Dean, Foster Wheeler Corp., New York, in *Power*

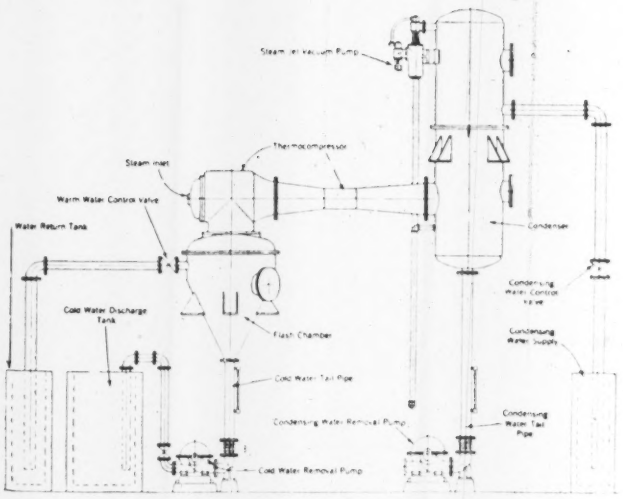

FIG. 5 DIAGRAM OF EQUIPMENT USED IN A TYPICAL VACUUM-REFRIGERATION SYSTEM

Plant Engineering, vol. 136, no. 6, Mar. 15, 1932, pp. 250-251, 3 figs., *d*)

Air Conditioning

THE full title of this article is "Dichloromethane and Dichloroethylene as Refrigerants." Only the mechanical engineering features of the subject will be dealt with here. Air conditioning is characterized by great variations in the load factor, amounting to as much as from 100 per cent to zero load in a matter of a few hours with an ordinary change in weather. The variations in weather conditions must be

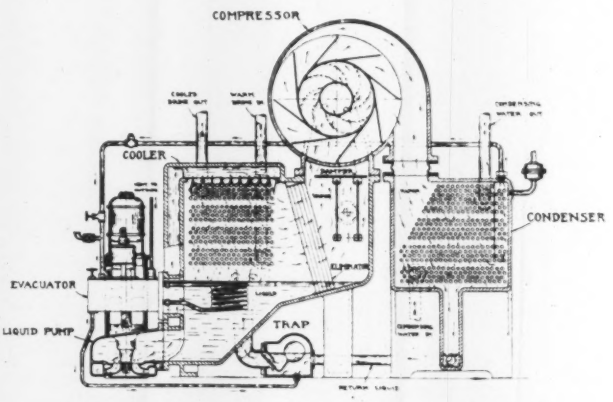

FIG. 6 DIAGRAMMATIC ARRANGEMENT OF AIR-CONDITIONING GENERATING SYSTEM SHOWING REFRIGERANT CYCLE

quickly and accurately followed by the machine if efficient operation is to result and conditions are to be kept at the optimum. This can be done with automatic control. The ability to meet these conditions is inherent in a centrifugal compressor through its full flexibility and ability to float with the load demands.

The author considers next the characteristics of the two refrigerants listed in the title for use in centrifugal compression systems.

The temperature stability of the centrifugal machine makes it easy to maintain either a constant refrigerant temperature in the evaporator, or a constant cold-water temperature to or

from the evaporator. It is thus entirely practical to cool fresh water to 34 F, under varying load conditions, in a shell-and-tube cooler without danger of freezing and bursting the tubes.

Fig. 6 shows the diagrammatic arrangement of the centrifugal refrigerating system and the cycle of the refrigerant. The refrigerant charge is contained in the bottom of the cooler. To obtain refrigerating effect, the liquid is pumped in a shower over the tube surfaces, giving a flash-type evaporation. This results in a very efficient heat transfer without appreciable friction or superheat loss in the cooler. The cooler and condenser tubes are of brass. They do not scale and are easily cleaned on the water side. The refrigerant side always remains clean, as there is no oil in the refrigerant spaces of the system. The refrigerant is also effective in keeping these surfaces clean, resulting in a high maintained efficiency throughout the life of the equipment. (R. W. Waterfill, Carrier Engrg. Corp., Newark, N. J., in *Industrial and Engineering Chemistry*, vol. 24, no. 6, June, 1932, pp. 616-619, 6 figs., *d*)

SPECIAL MACHINERY

Pneumatic Riveters for Russia

A NUMBER of pneumatic riveters of various sizes have recently been completed by Fielding and Platt, Ltd., of Gloucester, for export to Russia. They are of the squeeze type, operated by a pneumatic cylinder. The machine illustrated operates on a principle first applied by the firm in 1898, and since improved. The piston, Fig. 7, actuates a hinged lever by means of balanced rollers working on an inclined

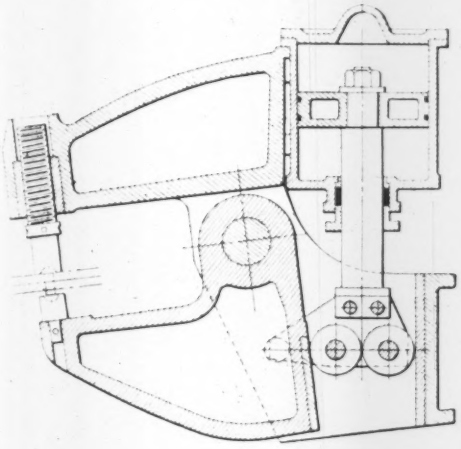

FIG. 7 BRITISH PNEUMATIC RIVETER BUILT FOR RUSSIA

plane. The contour of the roller path is so arranged that during the earlier part of the working stroke the power on the snap increases approximately in proportion to the resistance offered by the rivet, the full power only being exerted when forming and finishing the rivet head. The full power of the riveter remains approximately constant for a definite portion of the latter end of the stroke, thus allowing for variations in the lengths of the rivets handled and in the thickness of the work. The adjusting screw for the snap need only be used if there are radical changes in the nature of the work. The air used for the working stroke serves afterward by its expansion to effect the return stroke. The riveter illustrated has a 24-in. × 21-in. gap, exerts a pressure of 80 tons, and is suitable for driving $1^1/_4$-in. rivets. The specified speed of the machine is 450 $1^1/_4$-in.-diameter rivets an hour through 3 in. total thickness. We are informed by the makers that during the official tests 116 rivets were closed in ten minutes, equal to a rate of 696 rivets per hour. Subsequently, the machine demonstrated that it was capable of dealing with $1^1/_2$-in. rivets satisfactorily. The makers state that careful tests during which the power actually developed by the machine has been definitely measured, showed that under full load it has a mechanical efficiency of 80 per cent.

The machine is of very simple construction, the principle of operating being the same as that of the riveter just described, applied in a different manner. A double-acting cylinder is employed to insure the greatest rapidity of operation, and the makers state that this riveter can be worked more rapidly than the other type. An illustration in the original article shows a 50-ton riveter with a 20-in. gap for 1-in. rivets, hot. That the machine has ample power may be gathered from the results of the official tests. The makers claim that the riveter closed satisfactorily a number of rivets of the maximum size, utilizing an air pressure of 85 lb per sq in., although the specified pressure is 100 lb per sq in. (*The Engineer*, vol. 153, no. 3988, June 17, 1932, p. 676, 3 figs., *d*)

SPECIAL PROCESSES

Electric Resistance Welding of Steel Tubing

THIS is a description of the process as practiced by Tube Products, Ltd., at Oldbury, England. There are two continuous welding systems. The first is used for making high-quality welded tubing. The strip is first passed through a series of rolls which form it into a tube, and as it travels forward the seam passes between two disk electrodes and is automatically welded. The current flows across the seam and not longitudinally parallel to it. One effect of this is that the area of tube actually heated to obtain welding temperature at the seam is small. The electrodes are two large-diameter copper disks arranged close together with their rims pressing one on either side of the seam. The electrodes revolve as the tube travels forward. The edges are square with the strip surface. This is said to give a V-groove along the seam when the tube is formed. No information is given as to how the pressure is produced in the seam. The rolls of strip received from the makers are as a preliminary to use rewound on larger frames, a number being joined together in a continuous length by butt welding the ends. In this way non-stop runs producing up to three-quarters of a mile of tubes are made possible. Tubes of an intermediate size, from $^1/_2$ in. to $2^1/_4$ in. in external diameter and in thicknesses up to 14 gage, are made at speeds of from 60 to 100 ft per min.

The frequency of the line supply is stepped up to 100 cycles by a frequency changer. A different system of resistance welding is employed for making black-finished tubing. Here the welding current is applied longitudinally along the seam and not across it. Disk electrodes are employed, but each disk bridges the seam, making contact on either side, and current circulates from one electrode to the next place further along the tube. Heating is accomplished in three successive stages, preliminary, intermediary, and actual welding. There are three pairs of electrodes, one pair per stage. In this case frequency is not so important, and 50-cycle standard is utilized.

On the latest type of machine, automatic induction regulators have been installed for voltage control, and the regulation is within the limits of ± 0.1 volt on the secondary side. To insure that the various sections of the complete machine—tubing, forming, welding, finishing, and cutting into lengths—run in perfect unison, the two driving motors are controlled in

synchronism, being interlocked electrically to insure simultaneous starting and stopping. It is stated in the original article that such factors as voltage between electrodes, current magnitude, degree of mechanical pressure of the electrodes on the tubing, rate of travel, etc., including energy consumption, are trade secrets.

In bending light tubing, resin instead of sand is used for a core. Its advantage over sand is said to be that both pouring in molten resin in the first place, and melting it out again after shaping, are simple processes. From the description it would appear that the process is the same as that used by the Steel and Tubes, Inc., in this country. (*Electrical Times*, vol. 81, nos. 2099 and 2100, Jan. 14 and 21, 1932, pp. 45–47 and 79–81, 10 figs., *d*. Only the second of the two articles deals with the Tube Products method.)

Metallization as a Protective Process

THIS article deals with metal spraying, such as that of the Schoop process. It can be effected with zinc, aluminum, nickel, and tin, but under certain conditions lead, copper, bronze, and brass can be used. The process can be applied to the coating of non-metallic articles such, for example, as the insulating materials used in high-tension work for the prevention of corona.

Sprayed coatings can be applied to any desired thickness in excess of 0.001 in. The section of the metallite should be of an open texture and thoroughly clean. With metal articles this condition is obtained by sand blasting, which should be carried out immediately before spraying. To get a sufficiently open grain it is necessary to use a heavy pressure and special hard sand. The air pressure used is 30 lb per sq in., and the sand is black flint of 20-mesh grade. Ball shot is not satisfactory, but angular shot can be used. For most purposes a $^{5}/_{16}$-in. nozzle is used, consuming about 100 cu ft of air per minute.

One of the uses of metal spraying which is rapidly coming to the front is that of protecting iron and steel from high-temperature oxidation by means of aluminizing. The articles to be treated are sand blasted and sprayed with aluminum in the usual way. They are then painted with a bituminous flux and heated rapidly to 700 C in a furnace. The aluminum alloys with the iron, and the surface layer oxidizes, forming a film of alumina which prevents further scaling temperatures within the region of 950 to 1000 C.

The superheaters of the German fast ships, the *Bremen* and the *Europa*, were aluminized by this process. Cast iron is also protected by aluminizing, but the iron should have a low silicon content or a composition which is not subject to growth as is ordinary cast iron. The article deals primarily with British practice. (*The Metal Industry*, vol. 40, no. 10, Mar. 4, 1932, pp. 277–279, *d*)

STEAM ENGINEERING

The Quadropod

THIS is a quadruple-expansion steam engine now under development by the Central Marine Engine Works in England. Its object is to obtain high efficiency of propulsion for large cargo steamers, combined with simplicity of operation. It has a four-cylinder quadruple-expansion engine with drop valves fitted to all its cylinders. The steam pressure is 260 lb per sq in. No further information is available. (From a statement by Maurice Gibb in *Shipbuilding and Shipping Record*, vol. 39, no. 17, Apr. 28, 1932, p. 471, *d*)

THERMODYNAMICS

Heat of Vaporization of Water at Low Temperatures

THIS publication deals with the values of the heat of vaporization of water at 50, 70, and 90 C. The thermal properties of saturated water and steam in the range from 0 to 270 C as measured at the U. S. Bureau of Standards have already been published. The determinations of the heat of vaporization given before extended from 100 to 270 C. Since the publication of the first paper it has been possible to extend the measurements of the heat of vaporization down to 50 C. These measurements have been carried out under the direction of N. S. Osborne and H. F. Stimson, and the values have been determined respectively as 2381.6, 2333.6, and 2283.4 international joules per gram.

The measured values below 100 C are in excellent agreement with those obtained by extrapolation from the measures above 100 C. Equations are given for calculating the values of β and L, using the values of u' given by Keyes and Smith, "Some Final Values for the Properties of Saturated and Superheated Water," in MECHANICAL ENGINEERING, vol. 53, 1931, pp. 132–135. (E. F. Fiock and D. C. Ginnings, *U. S. Bureau of Standards Research Paper*, no. 416; also published in *Bureau of Standards Journal of Research*, vol. 8, March, 1932, 4 pp., *e*)

VARIA

Foreign Patent as an Anticipation of an American Patent Application

SIX cases brought before the Court of Customs and Patent Appeals hinged upon the application of a foreign patent as an anticipation of a United States application. In one case (Gillam) the Court stated: "In the case of foreign patents it has been held that they cannot be measured as anticipatory by what might be made out of them, but only what is clearly and definitely expressed in them."

In another case, however, the decision says, "If the descriptions and drawings of a foreign patent contain or exhibit a substantial representation of the patented invention in full, clear, and exact terms, so as to enable a person skilled in the art or science to which it appertains, without the necessity of making experiments, to practice the invention, then it will be a complete anticipation. (Permutit Co. vs. Harvey Laundry Co., 279 F. 713)."

Another decision presents the same basic idea in a somewhat different wording, namely, "Appellant, in view of (the) apparent disclosure of the French patent, invokes the rule that a foreign patent is to be measured as anticipatory not by what might have been made out of it but by what is clearly and definitely expressed in it. This is undoubtedly the law. An American patent is not anticipated by a prior foreign patent unless the latter exhibits the invention in such full, clear, and exact terms as to enable any person skilled in the art to practice it without the necessity of making experiments." (Thos. H. Byron, in *Journal of the Patent Office Society*, vol. 14, no. 6, June, 1932, pp. 518–522, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer.

SURVEY OF SCREW THREAD PRACTICE IN THE U. S. A.[1]

THE American national standard for screw threads for bolts, machine screws, nuts, and tapped holes has been available for more than ten years. This standard is embodied in Section III of the Report of the National Screw Thread Commission, in A.S.A. Report No. B1a-1924 of the Sectional Committee on the Standardization and Unification of Screw Threads, in the S.A.E. Handbook, and in U.S. Department of Commerce Commercial Standard CS24-30.

In order to obtain some measure of the extent to which these specifications are used, and also (to obtain some measure) of the degree to which the tolerances are actually maintained, a survey has been conducted by the Sectional Committee on Standardization and Unification of Screw Threads, of which Mr. Ralph E. Flanders is Chairman, with the Bureau of Standards cooperating.

In addition to various other pertinent details, this survey was undertaken to show:

(1) The actual state of screw-thread standardization in the United States at the present time

(2) The range of accuracy desirable for an acceptable product of a given class

(3) The range of accuracy commercially attainable.

This preliminary report of the survey covers only the three foregoing features. A more complete report, now being prepared, will cover in detail the many significant and interesting features brought to light by the survey.

In conducting its investigation, the Subcommittee on Screw Thread Survey compiled a list of firms from whom samples of threaded product were to be obtained. This list was carefully made with the object of including different interested groups and industries, with a proper proportion of users and manufacturers, and also of producers and small producers. The samples were selected on the basis of the normal product of the firm supplying them. In most cases, five samples of each size available of twelve predetermined sizes were selected; seven sizes from the coarse-thread series and five sizes from the fine-thread series. In some cases, studs threaded at both ends were secured. In this report each threaded end is listed as a separate sample.

The Committee's field representative recorded on suitable forms, at the time a group of samples was obtained, the size, material, intended class of fit, and method of threading the individual samples. Definitely correlated with the samples was the information as to the standard worked to, namely the American national, U. S. standard, etc., and whether the threaded product was manufactured there or purchased. These samples were sent to the Bureau of Standards where they were measured and classified. The samples were not only checked with gages but also various individual elements of the threads were measured. The samples were then classified in two ways: first, by *gaging*, and second, by *all measurements*. In this preliminary report, the classification by gaging only is considered, as such a classification represents best the normal inspection methods in industry. The classification by all measurements showed a slightly greater number of rejections because of faults in major and minor diameters, angle and lead of thread, etc., than that by gaging alone, but in general, the agreement between the two methods was quite close.

[1] This preliminary report was prepared for the Subcommittee on Screw Thread Survey by Prof. Earle Buckingham. The members of this subcommittee are R. E. Flanders, chairman, C. W. Bettcher, and E. Buckingham.

EXTENT TO WHICH THE AMERICAN NATIONAL STANDARD HAS BEEN ADOPTED

In most cases, the samples received were designated in one of three ways:

(1) As a definite class of the American national standard

(2) As U. S. standard or commercial

(3) With no definite class number or with special tolerances, many of them for stud fits.

Only those in the first group which were specified as a definite class of fit have been accepted as samples definitely striving to meet the specifications of the American national standard. The numbers of samples falling into the two groups, namely American national standard and commercial or unclassified are shown in the accompanying table.

Size	American national standard	Commercial and unclassified	Total	American national standard	Commercial and unclassified	Total
	Screws, coarse-thread series			Nuts, coarse-thread series		
6–32	155	155	310	119	95	214
10–24	175	159	334	129	118	247
3/8–16	398	325	723	318	238	556
1/2–13	382	325	707	315	220	535
3/4–10	336	272	608	271	206	477
1–8	238	201	439	203	169	372
1 1/4–7	155	95	250	150	61	211
Total	1839	1532	3371	1505	1107	2612
	Screws, fine-thread series			Nuts, fine-thread series		
3/8–24	204	89	293	175	74	249
7/16–20	145	45	190	128	50	178
1/2–20	142	80	222	157	70	227
5/8–18	127	40	167	147	48	195
1–14	43	10	53	79	15	94
Total	661	264	925	686	257	943
	Total, coarse- and fine-thread series					
Total	2500	1796	4296	2191	1364	3555

If the survey gives a fair measure of screw-thread practice throughout this country, it would appear that the American national specifications have been adopted for about 55 per cent of the coarse-thread-series product, for about 72 per cent of the fine-thread-series product, and for about 60 per cent of the total product of both series.

DEGREE OF SUCCESS ATTAINED IN MEETING THE STANDARD

Numerous tables and charts have been made in the study of the data obtained from the measurement of the eight thousand samples. A study of these show that a little less than one-half of the samples met the specifications. This, of course, represents the average of good, indifferent, and poor conditions. In many cases, practically all of the samples received from a single source met the specifications, while on the other hand, in a few cases, practically none of the samples received from a single source met the specifications. Again, some of the nuts listed as small, particularly on the sizes over 3/4 inch, met all specifications except for too small a minor diameter. Evidently in such cases the specified clearance for the minor diameters of tapped holes has been ignored.

Space limitations at this time will not permit of a more detailed discussion of phases of the study. The full report will show the classification by type of industry, the comparison of

(*Continued on page 666*)

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of the Committee in Cases Nos. 725 and 727, as formulated at meeting of May 20, 1932, and Cases Nos. 724, 726, 728, 729, and 730, as formulated at meeting of June 23, 1932, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 724

Inquiry: Is it acceptable, under the rules of the Heating Boiler Section of the Code, for boilers to be operated at not to exceed 15 lb steam or 30 lb water, having a volume as determined from the overall dimensions not to exceed 50 cu ft, to attach stays, staybolts, and staybolt parts, to plates requiring support, by fillet welds instead of inserting through chamfered holes and welding as required by Par. H-83 provided said stays are fitted snugly to the plate for the full cross-section of the stays before welding and provided the fillet welds are made to conform with Class 2 test requirements of Section VIII of the Code (Par. U-69)? Destructive tests of the construction proposed as shown in Fig. 28, the results of which have been submitted, have shown these forms of attachment to be safe.

Reply: Based on the test results submitted, it is the opinion of the Committee that if the stays described in the inquiry and as shown in Fig. 28 are welded in the way proposed the construction shown may be considered the equivalent of the form of staybolt attachment specified in Par. H-83 for use in boilers under the conditions specified.

CASE NO. 725

(In the hands of the Committee)

CASE NO. 726

Inquiry: An interpretation is requested of the requirement in Par. P-111 of the Code limiting the circularity of a cylindrical shell to 1 per cent. Does this limit apply to the total circumference or does it signify 1 per cent plus or minus the specified diameter?

Reply: It is the opinion of the Committee that the maximum variation in circularity of a cylindrical shell specified in Par. P-111 shall be based on the difference between the maximum and minimum diameters at any section which shall not exceed 1 per cent of the nominal diameter.

CASE NO. 727

Inquiry: In the application of a fusion-welded nozzle which requires stress relieving, to a Class 2 vessel which is not required to be stress relieved, is it permissible to locally heat the nozzle and an annular ring of the shell around the nozzle?

Reply: It is the opinion of the Committee that where nozzles are required to be locally stress relieved, Pars. P-108 and U-76 of the Code require the simultaneous stress relieving of the

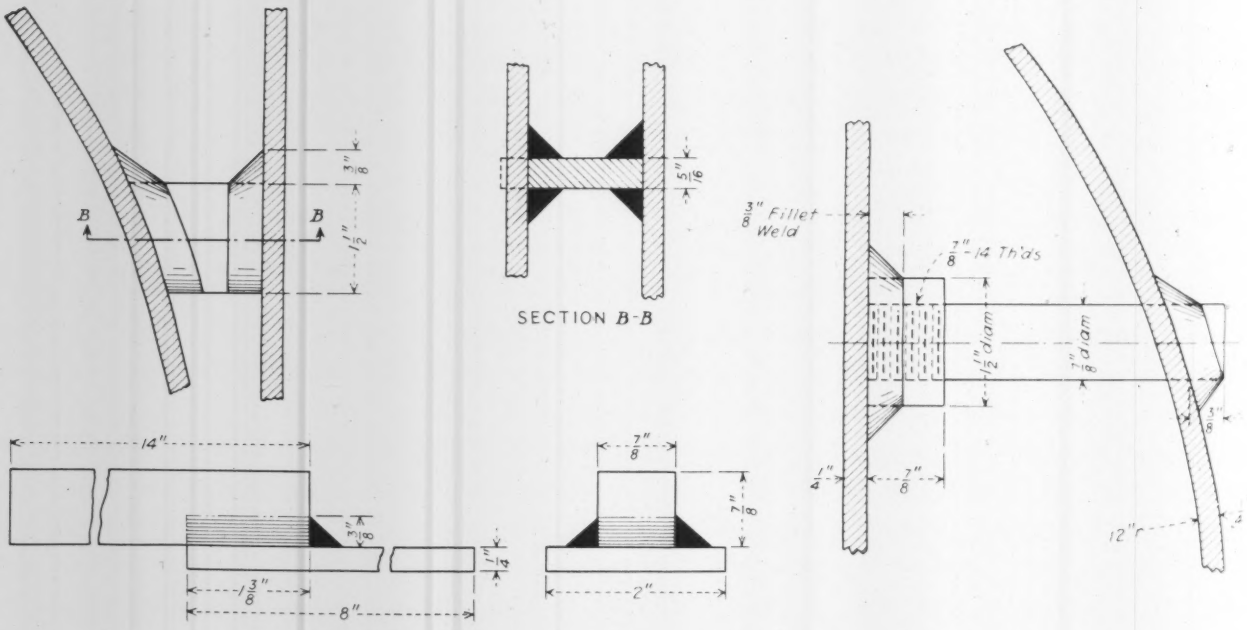

FIG. 28 DETAILS OF STAYBOLT WELDING FOR HEATING BOILERS

nozzle and a band of the width specified in Figs. P-6 and U-16, extending entirely around the circumference of the vessel.

CASE NO. 728

Inquiry: Is it not desirable that the edges of the hole in the die block shown in Fig. 1 of Specifications S-17 for making flange tests of boiler tubes be rounded off, preferably to a radius of $^1/_{32}$ in., in order to avoid a sharp corner? Attention is called to the fact that Pars. P-249 and L-51 of the Code call for the removal of the sharp edges of the tube holes where tubes are fitted into the tube sheets of boilers.

Reply: It is the opinion of the Committee that the provision of a sharp corner in the die block for making flange tests will cause unnecessarily severe treatment of the tube and the Committee therefore believes that it will be desirable to revise this illustration to show a rounding of the corner to a radius of $^1/_{32}$ in.

CASE NO. 729

(In the hands of the Committee)

CASE NO. 730

Inquiry: Is the limitation in the fourth line of Par. L-42 of the present edition of the Code for Boilers of Locomotives correct where it states "*P* shall not exceed $2T^2$" Attention is called to the fact that the term *P* as used in the formula refers to the maximum allowable working pressure and this would obviously permit only an extremely low working pressure.

Reply: The use of the term *P* in the fourth line of Par. L-42 (present edition of the Code for Boilers of Locomotives) is a typographical error and the term *p* should be used referring to the pitch in inches.

Correspondence

CONTRIBUTIONS to the Correspondence Department of "Mechanical Engineering" are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Current Problems of Industrial Management

TO THE EDITOR:

Mr. Mooney's paper[1] has brought to our attention a number of the defects and weaknesses in our present industrial system.

One of the principal weaknesses is that business units, in too many instances, lack definite objectives. There is too much confusion between administrative functions and the functions of management. Administrators have been concerned not with the sphere of policy or with the problems of fitting the particular industry to its economic, political, and social environment but too much with the sphere of management and with day-to-day details and tactics. It seems to me that, for lack of a better term, we need some "engineering philosophers" as administrators; men that will use the factual matter, principles, and laws available and consider how and in what way the business unit is going to proceed toward the predetermined objectives; men who will try to orient themselves and the business units over which they preside with the trend of economic, sociological, psychological, political, and other forces.

Our technique of production and the creation of wealth is far ahead of our technique of distribution and the distribution of wealth. I can, therefore, concur with the author's statement that probably one of the greatest weaknesses of industrial organization during the past decade has been the faulty control of the relationships between production and distribution. The cost of sales of some products, i.e., labor, material, and factory overhead, requires a spread of from 4 to 5 to 1, that is, the consumer ultimately pays four or five times the cost of producing the article at the factory.

I further agree as to the trend or drift toward state socialism, but unless industry and individuals show by their initiative that the present individualistic system can be modified and its faults corrected, and there are many faults and weaknesses in it, I fear that the trend toward state socialism will persist in spite of unorganized resistance. The next six months or the next year, in my judgment, will bring about the real test as to whether we are going to proceed more and more along lines of state socialism or thoughtfully, carefully and intelligently work along with the present industrial system, modified and corrected, however, to eliminate those faults and defects and lack of means of control which the present prolonged and severe recession in business has developed.

It is time to take count of stock and to examine our existing machinery and mechanism for supplying the wants and needs of the people of this country before running the machine into the ditch as is being so persistently suggested. Many defects are over-emphasized, many parts of the economic picture are distorted and appear to be the result of causes almost entirely remote from the actual causes when only superficial examination and consideration are given. This country has risen to a higher standard of living and enjoyment by the people as a whole under the system that has prevailed here than has any other nation in the world. This does not necessarily imply that the system *per se* is omnipotent and therefore perfect, but it does mean that if sound engineering study, analysis, and conclusions are applied to the problems which the engineer knows, from experience and association, exist and if engineering knowledge is pooled and coordinated, we can, in all probability, remodel our industrial machinery to suit present-day conditions. In too many cases the "horse and buggy" age and "horse and buggy" type of thinking are applied to the "airplane" age instead of "airplane" type of thinking. I have strong hopes that just such papers as Mr. Mooney's will stimulate discussion and thinking among the engineering fraternity in a way that will permit engineers to make a real contribution toward the improvement of our present industrial system.

I would like to see the several sections of this paper assigned to groups of members qualified to deal with them, with the thought that fundamental concepts and principles should be invoked to build up a background for this paper and ultimately develop concrete conclusions and recommendations.

HAROLD V. COES.[2]

New York, N. Y.

TO THE EDITOR:

Increasing tax burdens and increasing degrees of social control undoubtedly make the problems of government matters of

[1] "Current Problems of Industrial Management," by J. D. Mooney, MECHANICAL ENGINEERING, July, 1932, p. 467.

[2] Manager, Industrial Department, Ford, Bacon & Davis, Inc. Mem. A.S.M.E.

increasing interest to industry. It is evident that these powerful economic forces can be developed to the point where private industry and individual initiative are throttled. With the increasing complexity of our civilization there must go, probably, an increasing degree of social control. Most people feel that individual initiative has been and will continue to be one of the most beneficial aspects of our western civilization. It is probable, therefore, that it will become increasingly necessary to determine the point of diminishing returns beyond which social control cannot safely be developed. While it can, undoubtedly, make many valuable contributions, the satisfactory solution of this problem requires considerably more than the application of the scientific method of attack. It requires the development of a tradition of good government. In the development of such a tradition, we have much to learn from our English and Canadian friends. In the United States, business has become the honored career. Our best brains have tended, quite naturally, to be drawn into business. The man who has elected a political career often has been suspected of being politically unmoral, if not actually dishonest, for no other reason than that he has elected a political career. Until our national psychology is changed in this respect, it is a question whether or not there can be any permanent solution for many of our political problems.

We must agree with Mr. Mooney's estimate of the undesirable social and economic effects of high turnover and insecurity of income among industrial workers. We can hardly expect a reasonable degree of loyalty and high morale unless we extend the same degree of loyalty to our employees. Executive effectiveness depends to a considerable degree on willing cooperation. Without loyalty and morale, willing cooperation is not likely to exist, but rather, that degree of cooperation that can be bought or obtained by force. In almost any organization, there is a distinct difference between what is required to "get by" and the best performance of which one is capable. In general, this statement is true regardless of the excellence of the supervision. Good supervision narrows but cannot eliminate the gap between the two. The economic value of high morale lies in its ability to increase the probability that we shall be able to obtain "best performance." Industry, consequently, should be interested in a greater measure of economic security for its employees, if for no other than ordinary business reasons. It is doubtful, however, that we need new and broader wage and personnel philosophies. It is more likely that what we need are broader, more wide-spread and more intelligent applications of philosophies that already have been worked out by past and present leaders of economic and management thought.

No doubt there is a need for the development of managers into administrators. But there seems to be an even greater need for the development of a knowledge of organization economics among administrators. During the past two years, the public press has reported a large number of cases in which the troubles of the concern were due, in a considerable degree, to an amazing lack of such knowledge. The writer knows of one large chain-store organization that has had seven general managers in two years. Quite recently a case was called to his attention in which the president, the general sales manager, the comptroller, and the general superintendent were released at the same time. In another instance, a large mail-order concern opened five hundred and fifty retail stores in approximately two years. These may be examples of good management. In many instances, however, they are more suggestive of business hysteria growing out of a bad case of financial cold feet. Undoubtedly we could profit by more information bearing on the economics of organization. But our present difficulties again seem to be due, in part, to lack of ability or willingness to use the knowledge that we have at our command.

When most plants are shut down or are operating at a low percentage of capacity, it is painfully apparent that we have a distribution problem. As a result it is probable that a great deal of attention will be focused on distribution problems during the next few years. We have a tendency to become interested in a problem that attracts our attention to the exclusion of surrounding problems. The resulting development often goes through rather typical phases. The problem is discovered. We become highly enthused by its possibilities. Techniques for handling the problem are developed far beyond the point of diminishing returns. We find it necessary to squeeze out the water from the technology of the problem; to retrace our steps to solid ground. This has been true of personnel, cost accounting, production control, and almost any management movement of which one can think. Consequently, there is some danger that the increasing interest in the economics of distribution may result in a decreasing interest in the economics of production. Mr. Mooney speaks of the smooth-running mechanisms of mass production. But our large, continuous-manufacturing plants hardly are typical. The rank and file of our industrial plants still are in the stone age of management, in so far as the economics of production is concerned. It should not be forgotten that some of the best sales arguments are new products for new needs, new uses for old products, with increased quality and decreased cost, improved service, and reliable delivery. And these arguments are produced in the factory.

Mr. Mooney has stated that we must form our plans to make a fair return on our entire capital investment, but our only reasonable chance of doing this lies in hanging on to our market position. To do this we must meet current levels of prices. The first proposition seems to be born of hope and the second of hard fact that is becoming increasingly apparent, unless one is disposed to place faith in the various inflationary plans that are proposed. Unfortunately, the two propositions are not strictly compatible with one another. Not only were plants improperly located during the period of prosperity from 1921 to 1929, but they were built and old plants expanded with materials and labor bought at highly inflated prices. Capital structures were over-expanded with new stock issues and stock dividends. To meet much lower price levels on a profitable basis, it probably will be necessary for many concerns to deflate their capital structures.

We are greatly indebted to Mr. Mooney for a most stimulating discussion of current management problems.

RALPH C. DAVIS[3]

Columbus, Ohio.

Eight as a Basis for Our System of Numbers

TO THE EDITOR:

Arithmetic is the engineer's most important mental tool after language, but formal engineering criticism of the base ten as compared with base eight has not appeared since 1887.

We prefer to halve and double things and numbers, to think in steps of two, and not in steps of three and five. Doubling or halving, many times repeated, is easier with the base eight than with the base ten.

Analysis of the arithmetic base properly belongs with the psychologists, scientists of the mind and its relations to things and numbers, but where can a psychologist be found who even

[3] Professor, College of Commerce and Administration, Ohio State University.

recognizes that this is his job? It may remain for engineers to revise our arithmetic, money, weights, and measures to the base eight for the easiest working of the mind.

We are now afflicted with the base ten but a greater injury is caused by the absence of understanding and discussion of the subject. Possibly this is because arithmetic has been in the control of arithmeticians and educators rather than engineers and psychologists.

Simple finger counting in the early ages of our intelligence is responsible for our arithmetic base ten. Counting came before multiplication and division. Why should we continue to be oppressed with the arithmetic base of savages?

It is true that for purposes of calculation only, the bases eight, ten, and twelve, are nearly on an equality. But at the origin of the material for calculation, and in the transfer back from calculation, in the shop where a scale is read, or in the market where trades are effected by "splitting the difference," the mind prefers only the even divisions.

This preference is well illustrated by United States money, usually cited as the most perfect application of the decimal system. Note that five is avoided after passing one cent.

Tabulate our commonly used steps of value starting with twenty dollars on down to one cent and beyond through the fractions used in interest, stock and bond quotations, foreign exchange, and stock loaning rates, to one two-hundred-fifty-sixth of one per cent. Here are seventeen steps. Of these, fourteen are steps of two, two are steps of two and five (two and one-half), with only one step of five. English money is similar except in addition to the five they have a three to plague them.

Why should we not have only uniform steps of two, in money, weights, and measures, for our minds as well as the uniform stair steps we now have for our feet?

The saving of time in education and of mental effort with uniform world-wide measures would easily compensate for the work of changing from the base ten to the base eight. Other plans proposed are only time-serving expedients.

The four centuries during which decimal fractions have been used are nothing compared with a hundred centuries in which arithmetic will be used.

We pass on to the future generations our war debts. Why not do something to relieve their mental burden of the base ten and its associates?

It may require one or two generations to effect the change to the base eight. It should be done gradually by such changes as substituting four, eight, and double-eight dollar bills for our fives, tens, and twenties. The two-dollar bill is unpopular because it has no double. The foot should be changed to eight inches and the pound divided into eight ounces. All sequence numbers not involving calculation such as book pages and house numbers should be changed immediately.

In a short time children would count and write four, eight, eight and four, two eights, and would never know of our five, ten, fifteen, twenty counting.

E. M. TINGLEY.[4]

Chicago, Ill.

The Economics of Ground Rent

TO THE EDITOR:

I have read with a great deal of interest a number of articles on the economic situation published in MECHANICAL ENGINEERING and have been surprised that no one has called attention to the fact that the community by its presence and activity creates a fund which is its natural source of revenue and which should be used for community expenses.

This fund is ground rent. For instance, there is a little candy store on Euclid Avenue in Cleveland which I am told rents for $2000 per year per foot. It is very clear that this $2000 per year per foot is a community product due to the presence and activities of the million and quarter of people living in Cleveland and vicinity.

Since this $2000 per year per foot is community product and not individual product, good engineering would indicate that this should be taken for community purposes, and if this were done, burdensome taxes on wealth would be unnecessary.

I appreciate that this suggestion is radical but submit it as good engineering and good ethics.

It is clear that ground rent, actual or expected, when capitalized, equals land value. Land values arise, therefore, from the privilege granted to the holder of land titles to collect the ground rent created by the presence and activity of the community. The writer is told that there are spots in New York City where the privilege of collecting the community-created ground rent is worth over $400,000 per front foot.

If the public collected the ground rent which it produces it would not pay to hold land out of use or out of its best use.

Another result would be to very greatly lower the price of land. It would be possible to get land for a small payment plus the obligation to pay the ground rent to the public.

If we will look at the matter with a little care we will see that wealth-producing employment is the application of labor to land or the products of land and that land is absolutely essential to employment. The food we eat is simply land modified by labor. The coal that warms our houses and runs our machinery is land moved from the place where nature placed it to the places where it is needed. The houses we live in are land modified by labor. In all this production, labor is greatly assisted by capital. The point I want to emphasize is that land is the *primary* element in production. Therefore, land held out of use or out of its best use decreases employment to that extent. It happens that the writer lives in the country about 20 miles from the city of Cleveland and there are thousands of acres of land in this neighborhood held out of use because the owners cannot get the price for the land that they wish. If this land were used, it would provide jobs for some thousands of people, which are certainly needed at the present time.

The fact that employment is simply the use of land or its products, apparently is generally not realized. The assumption is that capital has to be provided to make employment, but a little thought will show that the pioneers who settled in this country did so with practically no capital. Their labor was applied to the land which they occupied.

If the community would collect ground rent which its presence and activity create, this would make available hundreds of millions of dollars' worth of land which is now held out of use, would thereby create millions of jobs, in fact would provide more jobs than there are people to fill them, and therefore would of course do away with our present unemployment situation, and would create a condition where the wages of labor would rise very greatly on account of the fact that there would be more jobs than there were workers.

Until these fundamental relations are generally recognized, our present succession of good times and bad times will probably continue.

J. C. LINCOLN.[5]

Cleveland, Ohio.

[4] Commonwealth Edison Co.

[5] Chairman, Board of Directors, The Lincoln Electric Company.

BOOK REVIEWS AND LIBRARY NOTES

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Trustees, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Economic Control of Quality

ECONOMIC CONTROL OF QUALITY OF MANUFACTURED PRODUCT. By W. A. SHEWHART. D. Van Nostrand & Co., 1931. Cloth, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 501 pp., illus., $6.50.

REVIEWED BY E. F. WILSON[1]

PROBABLY nothing is more fundamental and important in engineering than a knowledge of the characteristics and behavior of materials. Yet in spite of the fact that engineers have realized for many years that the qualities of materials are variables, that is, statistical in nature, only recently have attempts been made to apply a technique adequate to deal with such data—modern statistical methods.

At last, however, there is presented to the engineering profession a comprehensive, scholarly, and practical exposition of these methods and their application to the problem of the control of quality. Dr. Shewhart is a member of the Technical Staff of the Bell Telephone Laboratories and is a practical engineer as well as a mathematical statistician. He has collected and clearly presented and interpreted the most recent developments in modern mathematical statistics which are applicable to this problem. In itself this is a great service to the engineer, since much of this material is scattered through the various scientific and mathematical journals and is far from clear to any one not familiar with the unique mathematics of advanced statistical method. To this Dr. Shewhart adds the original and valuable methods he himself has developed, which have been confirmed by practical engineering application and laboratory experiment.

Dr. Shewhart's major thesis, which is admitted by all engineers, is that the qualities of materials are variable. For example, the tensile strength of steel is not an absolute constant but will vary somewhat from piece to piece. This variation may be due to two reasons: (1) an assignable cause or (2) unassignable causes.

Roughly, an assignable cause is one that is determinate, one that can be isolated and controlled. Unassignable causes, that is, unknown or "chance" causes, are those that cannot be *economically* found, isolated, or controlled. Obviously it is desirable to reduce the variability of a quality to the minimum, and to accomplish this the assignable causes must be eliminated. For this purpose various statistical tests are presented to determine when the variation is probably due to an assignable cause, it being shown that this conclusion must necessarily be in terms of probabilities. However, even when all the assignable causes have been eliminated, there will still be some variability in the quality due to the unassignable or chance causes. These can never be eliminated, so the next problem is to develop criteria to test if this chance system remains constant. If it does, then it will be possible to predict the variation in the quality within limits. When this condition exists, the quality is said to be controlled, that is, predictable within limits.

This theory of control forms the basis of the book. The ramifications of this theory, however, are numerous and of great value in all engineering work. For example, the theory of sampling is fundamental in all engineering work, since many engineering judgments must be based on partial information. It is shown that things cannot be sampled indiscriminately. The quality to be sampled must be controlled, that is, the variability must be due to a constant system of chance causes. Considerable space is given to the technique of sampling, both the mathematical theory and its practical applications being thoroughly discussed.

A few of the other important engineering applications considered are the design for minimum variability, the amount of variability in a finished product caused by each of the different parts, how large a sample to take, how many measurements to take. All of these are considered primarily from an economic point of view.

The book is admirably arranged and exceptionally well written, so that one may read the expository sections dealing with the logic and applications before attempting the mathematics. In using it as a text for a class of graduate engineers, the reviewer found it unusually satisfactory. An excellent bibliography is included in an appendix while the numerous footnotes fulfil this requirement for the current literature.

[1] Research Dept., E. L. Phillips & Co., Engineers, New York, N. Y.

Lubrication Engineering

PROCEEDINGS OF THE FIFTH OIL POWER CONFERENCE devoted to Lubrication Engineering, under the joint auspices of The Pennsylvania State College and the Lubrication Engineering Committee of the Petroleum Division, A.S.M.E. Published by the School of Engineering, Technical Bulletin No. 14, 1932. Paper, 6×9 in., 105 pp., illus., $0.75.

REVIEWED BY WILLIAM F. PARISH[2]

THIS bulletin presents the series of lubrication papers that were read at State College on May 22, 1931, by the technical representatives of three oil companies refining and marketing lubricating oils made from the three principal crudes produced in this country.

Sometimes the impression exists that "good" oils can be

[2] Consulting Lubrication Engineer, New York, N. Y. Mem. A.S.M.E.

made only from some one crude. This opinion is held in face of the self-evident fact that all of the machinery in the country is being quite amply lubricated by oils made from all of the available crudes, and such machinery, as we can all note, is running with apparent satisfaction to its owners.

However there are important technical differences to be noted in the action of such machinery with oils made from the various crudes when the machines are operated under special conditions. Such differences are always of interest as they induce improvements in the manufacture of the lubricants made from the crudes that do not meet the current requirements arising from peculiarities in machine design or impossible conditions of service.

It has frequently been observed that the progress of machine design "irons out" many of the technical differences that may momentarily give preference to some peculiar characteristic of a lubricant made from one or another of our crude oils. This is as it should be. No machine should be made so sensitive that it can be lubricated only with a special oil made from a particular well. Machinery must be made to function with lubricants from all suitable crudes made and distributed in every country where such machinery is offered for sale.

As all industrial and other machinery has been speeded up to the highest productiveness, and as greater strains and pressures are involved in consequence, the study of the film strength and oiliness of the lubricants is important at this time. Study of machine-bearing design based on the action of the lubricants under every condition of service is also necessary for the advancement of the art of lubrication without which there can be but little general progress in machine construction. This is especially true when the speed and pressure limitations of the lubricants have been exceeded. Further advances are possible along the line of developing new lubricants and new methods of their application. This again involves machine design.

Therefore it is timely to have such technical discussions as those covered in the bulletin. From them it is possible to see the trend of the development and the direction that machine design and operation must take in the future.

The contents of the bulletin is as follows:

"Lubricant Testing (The Timkin Testing Machine)," by E. G. Boden and O. L. Maag. (Also published in Petroleum Mechanical Engineering, Trans. A.S.M.E., 1932, paper no. PME-54-5.)

"Bearing Design in the Light of Oil Film Pressure Investigation," by L. J. Bradford

"Fluid Film Lubrication as Applied to Railroad Journal Bearings," by F. O. Willhofft

"Lubricants From Coastal Crudes for Diesel Engines," by A. Ludlow Clayton

"Motor-Oil Relationship to Operating Conditions of Passenger Car Engines," by C. M. Larson

"Lubricating Internal-Combustion Engines With Mid-Continental Oils," by E. R. Lederer and E. W. Zublin

"Oil Film Pressures in an End Lubricated Sleeve Bearing," by L. J. Bradford.

Books Received in the Library

LES ACIERS SPÉCIAUX. Historique, Propriétés, Traitements, Fabrication. By G. Mars, translated by E. Pétrot. Dunod, Paris, 1932. Paper and bound, 7 × 10 in., 543 pp., illus., diagrams, charts, tables; paper, 140 fr.; bound, 150 fr. This well-known treatise on alloy steels, which was first published in German in 1922, is now presented in a French translation, which will be welcomed by those who cannot read German. Certain portions of the text have been modernized and extended by the translator and other portions have been condensed, but the special views of the author have been retained throughout.

AMERICAN MACHINISTS' HANDBOOK. By F. H. Colvin and F. A. Stanley. Fifth edition, McGraw-Hill Book Co., New York and London, 1932. Leather, 4 × 7 in., 1134 pp., diagrams, charts, tables, $4. This handbook has been popular for twenty-four years in machine shops and drawing rooms as a convenient source of reference on machine shop practice, standards, and materials. The new edition, the first in six years, has been carefully revised. Obsolete material has been removed, and new data have been added.

APPAREILS POUR LE CALCUL MÉCANIQUE DE L'INTÉGRALE DU PRODUIT DE DEUX FONCTIONS. By A. Nessi and L. Nisolle. Dunod, Paris, 1932. Cloth, 7 × 11 in., 17 pp., illus., diagrams, charts, 7 fr. Describes a mechanical integrator invented by the authors, which will give the integral of the product of two functions. The instrument is relatively inexpensive and can be dismounted into parts that can be used for other purposes in the drafting room. This pamphlet explains the theory of the integrator and illustrates its uses.

CONGRÈS DU GRAISSAGE (Strasbourg, 1931). Compte-Rendu. Société d'Éditions Techniques, Paris, 1932. Paper, 7 × 11 in., 736 pp., illus., diagrams, charts, tables, 100 fr. The sixty papers presented at this conference covered a wide variety of studies of the properties of lubricating oils, of methods of utilizing them, and of manufacturing and standardizing them. These are reproduced in full, with the discussions, in this volume, which will interest both makers and users of lubricants.

ELEKTRISCHE MASCHINEN, Vol. 3. Die Transformatoren. By R. Richter. Julius Springer, Berlin, 1932. Cloth, 6 × 10 in., 321 pp., illus., diagrams, charts, tables, 19.50 rm. A textbook upon the theory and design of transformers, which presents the subject concisely, yet comprehensively, with special emphasis upon magnetic, electrical, and thermal phenomena. The work gives a clear, logical presentation of the subject, suited to the needs of engineers and students. A brief bibliography is included.

FORSCHUNGSHEFT 354. DER DAUERSCHLAGBIEGEVERSUCH, Abhängigkeit der Schlagzahl von Fallgewicht und Fallhöhe. By M. Beilhack. V.D.I.-Verlag, Berlin, 1932. Paper, 8 × 12 in., 22 pp., illus., diagrams, charts, tables, 5 rm. Contains the results of a new investigation of the repeated-impact test, carried out with an improved testing machine. Special attention is given to the effect upon endurance of variations in the weight and drop of the hammer when the striking energy remains constant. Tests on brass, bronze, steel, and aluminum are reported in detail.

GENERAL TEXT ON AERONAUTICS. By H. F. Lusk. Ronald Press Co., N. Y., 1932. Cloth, 5 × 8 in., 420 pp., illus., diagrams, charts, maps, tables, $3.25. The fundamentals of aeronautics are presented in suitable form for use in technical institutes, junior colleges, and avaiation ground schools where students are being trained for positions in the aviation industry. The principles of flight, the construction of airplanes and engines, the instruments used, piloting, meteorology, etc., are discussed in elementary fashion, so that the book gives a good introductory course, which covers the information that the Department of Commerce expects airplane pilots to learn in ground schools.

GESCHICHTE DER PHOTOGRAPHIE, Vol. 1, Part 1, First Half and Second Half, 2 Vols. Fourth edition. By J. M. Eder. Wilhelm Knapp, Halle (Saale), 1932. Cloth, 6 × 9 in., 1108 pp., illus., diagrams, tables, First Half, 41 rm.; Second Half, 38 rm. A new edition of this valuable history was needed, for the book has long been out of print. Dr. Eder covers the subject comprehensively and thoroughly, from the earliest times to the present day, and presents a clear picture of the gradual growth of knowledge that led up to the discoveries of Niépce and Daguerre, and of developments since that period. No branch of photography is neglected. The new edition is enlarged and brought down through the first quarter of the twentieth century.

GLASS FACTORY YEAR BOOK AND DIRECTORY, 1932 Edition. Pittsburgh, American Glass Review. Leather, 5 × 8 in., 152 pp., illus., tables, $3. A well-arranged directory of the manufacturers of glass, with information as to officers, equipment, and products. The directory also lists them by products and includes lists of trade associations and workers' unions, statistics of the industry, and miscellaneous technical data.

HISTORY OF EXPERIMENTAL PHYSICS. By C. T. Chase. D. Van Nostrand Co., New York, 1932. Cloth, 6 × 9 in., 195 pp., illus., $2.25. Dr. Chase devotes his book to the development of physics as an experimental science, from the days of Galileo to the present time. Attention is directed to the researches that have made history, and the reasons why these are of interest are made clear. Present developments are

clearly described without the use of mathematics. The book supplies an interesting account of the gradual advance of knowledge in this field.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN GHH-KONZERNES, Vol. 2, No. 1, May, 1932. V.D.I.-Verlag, Berlin. Paper, 9 × 12 in., 34 pp., illus., diagrams, charts, tables, 3.80 rm. The two papers here presented treat recent developments in marine engineering. The first reviews the development of Diesel engines in the German navy. Both two-cycle and four-cycle engines are described. The principal structural details are discussed and the results of tests given.

The second paper presents results obtained with the Voit-Schneider propeller applied to river steamers.

PROBLEMES THERMOMECANIQUES DU MOTEUR A ESSENCE. By D. Jacovleff. Dunod, Paris, 1932. Paper, 5 × 8 in., 280 pp., diagrams, charts, tables, 25 fr. The problems of the gasoline engine which are here considered are those in which thermal questions are of the greatest importance. The problems of fuel feed, carburation, knocking, and cooling are discussed, with special reference to their effects upon the construction of the engine. The effects of altitude are also discussed, and there are chapters upon two-cycle engines and Diesel engines. The text is as simple as possible and avoids higher mathematics.

QUANTITATIVE ANALYSIS. By E. G. Mahin. Fourth edition. McGraw-Hill Book Co., New York and London, 1932. Cloth, 6 × 8 in. 623 pp., illus., diagrams, charts, tables, $4. This popular textbook aims to provide a theoretical and practical discussion of the subject suited to the needs of college students. Emphasis is placed upon the scientific principles that form the basis of practical methods of analysis. The book discusses the general processes, the special measurements used in laboratories, and the analysis of the common industrial products and raw materials. This edition has been revised throughout.

RICHTIGE MASCHINENSCHMIERUNG, Kraftmaschinen, Arbeitsmaschinen, Transportwesen, Kraftfahrzeuge. By E. W. Steinitz. J. Springer, Berlin, 1932. Paper, 6 × 9 in., 177 pp., illus., diagrams, tables, 7.80 rm. A practical handbook on the lubrication of machinery, intended for operating engineers. The properties of lubricants and the conditions for proper lubrication are considered briefly, after which the lubrication of steam engines, oil engines, steam turbines, and hydraulic turbines is discussed. Lubrication practice in various industries, such as agriculture, cement making, mining, metallurgy, textiles, foods, paper, woodworking, and transportation, is then treated, after which attention is given to lubricating devices, oil recovery, etc.

Survey of Screw Thread Practice in the U. S. A.

(Continued from page 659)

cut and rolled threads, manufactured and purchased threaded product, etc., all of which should give a more complete picture of the present state of the art of making screw threads.

RANGE OF ACCURACY ATTAINED IN THE PRODUCTION OF SCREW THREADS

When all of the 7851 threaded samples of screws, studs, and nuts received are classified and tabulated on the basis of the highest classification into which they would fall regardless of the specifications to which they were made, those too large for any classification being listed as "large," and those too small for any classification being listed as "small," 6074 of the samples, as checked by gages, fall within some classification of the American national standards. Assuming that these samples give a fair measure of industrial requirements for threaded products, it would appear that the range of accuracy covered by these standards was satisfactory. Whether or not the subdivision of this range of accuracy into the several fit classes can be improved must be determined by a much more detailed study of the information gained in this survey.

A study of these data now available reveals much interesting information. Although Class 1 has been specified but seldom, it will be seen that about one-fifth of the product falls with this class (17.2 per cent). To summarize, we have

17.2 per cent in Class 1
20.5 per cent in Class 2
29.9 per cent in Class 3
9.8 per cent in Classes 4 and 5
17.4 per cent oversize or large
5.2 per cent undersize or small.

The thanks of the Sectional Committee and industry in general are due to the 128 firms which so generously contributed samples of screw-thread product for this investigation. The Committee thanks also the eight firms which loaned screw thread gages of various kinds to facilitate the measurements.

The expenses of the screw-thread survey are being met jointly by the Bureau of Standards and the Sectional Committee. The Committee's part thereof in turn has been subscribed by Engineering Foundation, the U. S. Machine Screw Service Bureau, and 36 firms which manufacture and use screw threads. The S.A.E. and the A.S.M.E. as joint sponsors for this project have assisted in many ways.

Plywood

(Continued from page 622)

depending on strength and beauty factors, as well as on size and thickness requirements. The lower grades for shooks, drawer bottoms, and similar purposes, approximately $\frac{1}{8}$ in. to $\frac{3}{16}$ in. thick, can be made for 2 to 3 cents per square foot. Fir plywood for concrete forms and building purposes, $\frac{1}{2}$ in. to $\frac{5}{8}$ in. thick, will range between 5 and 8 cents. With the rarer and more beautiful veneers, costs may vary between 25 and 50 cents and occasionally up to a dollar per square foot.

The elements in cost that differentiate plywood from solid wood are the relative primary costs of producing the thinner sheets and the secondary cost of applying the glue strata. If the ultimate product in plywood requires a substantially smaller volume of wood, this reduction may offset the cost of the glue operations.

Comparisons with solid wood are difficult, since the characteristics of the two materials are so different, and each has its inherent advantages. Plywood manufacturers have been aggressively improving their processing, until now plywood sometimes costs less and frequently little more than solid wood. Where either may be used, the advantages of plywood often far outweigh the cost differentials.

CONCLUSION

Plywood is ushering in the era of lighter weight as well as sturdier and frequently more beautiful wood products, all essential economic factors in our manufacturing and construction industries. Its progress may have been slackened by promotional inertia, but its merits are bringing it forcibly to the public's attention.

Plywood as such is a relatively unrecognized product and its possibilities have only been superficially investigated as yet. It is the conviction of the industry that, when the same degree of research and engineering skill have been devoted to plywood as to other materials, its field of service and its industrial adaptation will be far greater than they are at present.

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Air Compressors

FAILURES. Air Compressor Breakdown, E. Ingham. Colliery Eng v 9 n 99 May 1932 p 169–70. General notes on causes of breakdown; importance of efficient lubrication.

AIR CONDITIONING

REFRIGERATION. Using Ice in Air Conditioning, M. D. Woodling. Refrig v 51 n 5 May 1932 p 16–17 and 19. Comparison between mechanical and ice cooling mediums; cost of operating; engineering service available to all ice manufacturers; obtaining data for cost comparison; theater, restaurant and dry goods stores installations. Before South. Ice Exchange.

VENTILATION. Air Conditioning, R. E. Light. Power Engr v 27 n 314 May 1932 p 185–8. Application of ventilation control to industrial buildings; temperature and humidity charts; typical factory air-conditioning installations.

AIR PREHEATERS

TIGHTNESS. Dichtigkeitsgrad von Luftvorwaermern, H. Schlicke. Feuerungstechnik v 20 n 6 June 15 1932 p 86. Degree of air tightness of air preheaters; influence of tightness of preheater on steaming efficiency of boilers; measuring method to determine degree of leakage; means of increasing life of air preheaters.

AIRPLANE ENGINES

DESIGN. Der Luftfahrzeugmotorenbau der Gegenwart und seine Beziehungen zum Kraftfahrzeugmotorenbau, O. Kurtz. Automobiltechnische Zeit v 35 n 10 and 11 May 25 1932 p. 242–9 and June 10 p 276–84. Design and operating requirements controlling development of airplane and motor vehicle engines; possibilities of profitable exchange of experiences on basis of comparison of operating and design characteristics illustrated by charts.

INSTALLATION. Engine Mounting Stresses, R. Rodger. Flight v 24 n 1218 and 1222 Apr 29 1932 (supp) p 376e–376g and May 27 p 468e–468g. Routine methods to estimate strength of engine mounting structure; calculation of stresses during turning in flight with engine on, at stalling attitude; normal flight and landing, with engine off, at stalling attitude; static thrust and torque with aircraft at rest on ground, tail down; inverted flight, with engine off, at inverted stalling attitude; side load, with engine off, at vertical bank attitude.

VIBRATIONS. Torque Reaction and Vibration, H. Constant. Aircraft Eng v 4 n 40 June 1932 p 146–9. Investigation of causes of engine torque variations and their effect on aircraft structures with particular regard to differences in power output of cylinders of multi-cylinder engines.

AIRPLANES

CONTROL. Télécompas et stabilisateur automatique de cap système "Askania," pour la direction des avions. Génie Civil v 100 n 18 Apr 30 1932 p 443–6. Pneumatic operating principles and installation of automatic course stabilizer and telecompass built by Askania works, Berlin.

MACHINE TOOLS. Utilization of Machine Tools in Aircraft Manufacturing, M. Stupar. Aviation Eng v 6 n 6 June 1932 p 18–20 and 32. Use of turret lathe; milling machine; grinders; drill presses; punch presses; draw benches and press brakes.

METAL CONSTRUCTION. Jigs for Aircraft Construction, G. H. Handasyde. Aircraft Eng v 4 n 40 June 1932 p 143–5. Survey of current practice with suggestions for wider application to strip metal wing spars, wing assembly, fuselage assembly, fairing and cowling.

La technique de construction des avions métalliques modernes, G. Ivanow. Revue Industrielle v 62 n 2274, 2275 and 2276 May 1932 p 241–7, June p 299–304 and July p 344–52. Basical principles applied in design of modern metal-type airplanes by different designers; various metals used in construction and shape in which these metals are used; specifications of steel, non-corrosive steels, etc. shown in tables.

PROPELLER VIBRATIONS. Versuche ueber Luftschraubenschwingungen, F. Liebers. Zeit fuer Flugtechnik und Motorluftschiffahrt v 23 n 9 May 14 1932 p 251–9. Comparison of experimental and theoretical methods of determining vibration characteristics; results obtained by DVL with models of different propellers.

STRESS ANALYSIS. Kellett Solves Autogiro Structural Problems by Using Model Fuselage, J. Geschelin. Automotive Industries v 66 n 23 June 4 1932 p 808–10. Use of small-scale model to indicate points of stress in complicated structure by forecasting probable failures.

ALLOYS

ALUMINUM. See *Aluminum Alloys.*

BEARING METALS. See *Bearing Metals.*

ALUMINUM ALLOYS

CASTINGS. Effect of Temperatures on Physical and Casting Properties of No 12 Aluminum Alloy, G. H. Starmann. Metal. Industry (N. Y.) v 30 n 5 May 1932 p 181–2. Effects of overheating and uncontrolled melting practice and its accompanying disadvantages; macrophotographs and tabular data.

AUTOMOBILE ENGINES

COOLING. Solvent for Scale in Cooling Systems of Automobile Engines, W. Zumpe. Eng Progress v 13 n 5 May 1932 p 115–19. Results of tests conducted by Berlin Motor Bus Co. illustrate satisfactory performance of product of Groeck Wasserveredlung G.m.b.H. of Berlin; solvent consists of chromium compounds, which dissolve scale-forming salts and keep them in solution, and in addition increase resistance of metal surfaces against rusting or corrosion.

AUTOMOBILES

TRANSMISSIONS. Car Stresses Born of Free Wheeling Remain Within Normal Limits. Automotive Industries v 66 n 22 May 28 1932 p 789–90. Conditions existing when free-wheeling device takes up load after period of coasting with reference to paper before French Society of Automobile Engineers.

WELDING. Ford Car Parts Are Welded in Automatic Machines, E. F. Ross. Steel v 91 n 1 July 4 1932 p 23–5 and 28. Welding methods employed for various car assemblies; particular regard to wheel shells, rear axle shaft housing, torque tube and spare tire carriers.

AUTOMOTIVE FUELS

GAS. Use of Methane as Motor Fuel. Gas World v 96 n 2496 June 4 1932 p (coking section) 8–9. Review of existing practice and future possibilities.

AVIATION

MILITARY. Possibilities of "Air Tank"—Navies and Airplane, F. H. Wagner. Army Ordnance v 12 n 72 May-June 1932 p 407–11. Successful application of airplanes to bombing of ships illustrated by experiences in World War and bombing experiments.

Beams

BUCKLING. Laterally Unsupported Beams, A. N. Proctor. Structural Engr v 10 (New Series) n 7 July 1932 p 274–87. Compilation of data and theories on lateral stability of beams; working formula; torsion of I beams; eccentricity; failure by lateral buckling; beams encased in concrete; plate girders; through bridge girders. Bibliography.

DESIGN. Analysis of Statically Indeterminate Beams by Theorems Two and Three Moments, A. L. Miller. Univ Wash—Eng Experiment Station Series—Bul N 64 May 1 1932 51 p. Theoretical mathematical discussion of flexural elasticity and analysis of statically indeterminate beams; derivation and applications of theorem of two moments; supported cantilever beam; fixed-end beam with settlement; theorems of three moments; two-span and four-span beams; beams of variable cross-section; comparison of various methods.

STEEL. Strength of Light I-Beams, M. S. Ketchum and J. O. Draffin. Univ Ill—Eng Experiment Station—Bul N 241 v 29 n 45 Feb 2 1932 41 p. Jones and Laughlin Steel Corp. light I-beams, known as J & L Junior beams, are compared with strength of standard beams; tests for residual deflection under increasing load; failure of beams with upper flanges restrained from side-wise buckling; resistance of web to buckling; tests of beams with upper flange free to buckle sidewise; tests for compression of web over bearing block.

BEARING METALS

LEAD BASE. Arsenic in Ternary Lead Base Bearing Alloys, K. H. Wegner. Metals and Alloys v 3 n 5 May 1932 p 116–19. Metallographic investigation shows that arsenic content assists in formation of needle-shaped crystals containing arsenic-rich core consisting, probably, of ternary solid solution of arsenic, antimony and tin; interlocking of needles prevents segregation and permits production of uniform alloys.

BEARINGS

DESIGN. Ball and Roller Bearings for Reciprocating Motion. Engineering v 133 n 3467 June 24 1932 p 751. Design shown forms one of series of bearings suitable for carrying loads of from 250 to 6000 lb; other types of bearing embodying same principle are described.

Important Development in Ball and Roller Bearings. Ry Gaz v 56 n 22 May 27 1932 p 784. Details of three varieties of eliminator designed for use with reciprocating and sliding mechanisms; diagrams illustrating design features.

LUBRICATION. Film Lubrication of Journal Bearing, R. O. Boswall. Engineering v 133 n 3459, 3462, 3464 and 3465 Apr 29 1932 p 527–31, May 20 p 615–16, June 3 p 670–2 and 700–1. Fundamental principles governing operation of clearance and bedded brasses and experimental determination of operating conditions for clearance brasses. Before Instn. Mech. Engrs.

High Temperature Bearing Service Lubrication Requirements. Lubrication v 18 n 6 June 1932 p 61–6. Characteristics of bearing design and lubrication in machinery where steam heat is utilized for drying purposes, such as in textile, paper, and rubber industries.

BELT DRIVE

INSPECTION. Suggestions for Inspection of New Belting, R. C. Moore. Melliand v 4 n 2 May 1932 p 116–17. Suggestions offered for those plants that do not have facilities to make physical and chemical analysis of their belting to see if it conforms to either their own or Bureau of Standards specifications covering first-quality leather belting.

TENSION CONTROL. Automatic Belt-Tensioning Device. Engineering v 134 n 3468 July 1 1932 p 27. Simple and reliable means of ensuring constant tension on driving belt from motor with device introduced by Crofts Engineers, Ltd., known as Constension drive.

BLAST FURNACES

GAS PURIFICATION. Stand der Hochofengas-Nassreinigung, R. Walter. Stahl und Eisen v 52 n 26 June 30 1932 p 625–31 and (discussion) 631–3. Status of wet purification of blast-furnace gas; most important types of wet purifiers, including that of Theisen, Zschocke and Dingler; purification system with capacity of 200,000 cu m per hr of Vereinigte Stahlwerke at steel works in Dortmund-Hoerde; installations for purification of sludge water; cost data.

GREAT BRITAIN. Installing New Blast-Furnace Plant. Metallurgia v 6 n 31 May 1932 p 1–5. Features of plant erected at Dagenham Works of Ford Motor Co.

LININGS. Blast-Furnace Linings, W. J. Rees. Iron and Coal Trades Rev v 124 n 3352 May 27 1932 p 882. Enumeration of main factors operating to reduce life of blast-furnace linings, as deduced from investigations during 12 yrs. in Department of Refractory Materials of Sheffield Univ.; outline of suggestions to blast furnace managers. Before Ceramic Soc.

PRACTICE. Dry Blast for Pig Iron Production, J. B. Fortune. Iron and Steel Industry v 5 n 7 and 8 Apr 1932 p 255–9 and 268 and May p 287–92. Apr.: Various methods adopted or proposed for controlling amount of moisture admitted in air-blast; determination of effect of dried blast; flow sheet for Kestner silica gel air drying plant. May: Operating principles of Carrier centrifugal refrigerating machine and Holmes "Dri-Gas" plant; cost data.

La mise au mille de coke au haut-fourneau, J. Vallet. Revue de Metallurgie v 29 n 5 May 1932 p 238–40. Amount of coke necessary to produce 1000 kg of metal in blast furnace; it is shown how formulas developed by author can be applied to calculation, example of which is given.

REFRACTORY MATERIALS. Better Refractories Aid Blast-Furnace Practice, R. H. Sweetser. Min and Met v 13 n 307 July 1932 p 319–21. Brief review of progress in practice of manufacture of refractories for blast furnaces; examples of formation of salamander in blast furnaces; effect of salamanders on furnace lining and foundations; probabilities as to future use of mullite and sillimanite.

BOILERS

BLOW-DOWNS. Piping Blow-Down Which Saves $11.64 Daily, C. R. Hoey, Jr. Heat Piping and Air Conditioning v 4 n 6 June 1932 p 416–18. Details of piping for continuous blow-down systems which has shown heat savings amounting to over $11 per day; features are simplicity in operation and metering; schematic layout showing piping arrangement.

DESIGN. Boiler Machine. Power Engr v 27 n 314 May 1932 p 180–1. Details of research work conducted by Brown, Boveri Co. pertaining to steam generation operating on explosion principle for gas; comparison of constant pressure and explosion firing methods; section through small Brown Boveri Velox steam generator.

Trends in Boiler Design, W. M. Jacobs. West Gas v 8 n 7 July 1932 p 23–4 and 43. Review of developments in boiler technology; characteristics of each type of boiler, with special reference to conversion to natural gas firing; gas fired boiler of future will be higher pressure, of small size, and with low cost per developed horsepower.

FIRING. Burning of Liquid and Gaseous Fuels. Nat Elec Light Assn—Publ n 219 May 1932 13 p. Market conditions; automatic combustion control; use and maintenance of air headers; comparison of operation of boilers in which oil and gas are burned; use of oil and gas as auxiliary fuels; etc.

METALS. Les métaux utilisés dans la construction des appareils a vapeur a haute pression et a température élevée, J. Galibourg. Technique Moderne v 24 n 10 May 15 1932 p 306–9. Metals used in construction of high-pressure, high-temperature steam equipment; limiting creep stress; various strength curves; tests; application of special steels.

PLATE TESTING. Werkstoffuntersuchungen an alten Dampfkesseln, K. Daeves, E. Pfeiffer and G. Urbanczyk. VDI Zeit v 76 n 23 June 4 1932 p 551–6. Investigation of plates of 11 boilers in operation from 20 to 40 yr shows no change in properties of plates except excessive brittleness along riveted seam; interpretation of tests, particularly notched bar impact tests.

PULVERIZED COAL. Preliminary Tests of Thirteen Washington Coals in a Powdered Coal Boiler Plant at University of Washington, G. S. Wilson, H. F. Yancey and J. Daniels. Univ Wash Eng Experiment Station—Bul n 57 Oct 1931 27 p supp plates. Results of 24 boiler firing tests; descriptions and analyses of coals tested; details of boiler tests; results indicate that coals in state of Washington having characteristics similar to those investigated can be successfully utilized in powdered form in industrial steam-power plants.

PULVERIZED LIGNITE. Die Wirtschaftlichkeit der Braunkohlenstaubfeuer ungen in Abhaengigkeit von der Mahlfeinheit, H. Stimmel. Braunkohle v 31 n 23 June 4 1932 p 392–8. Economy of pulverized-lignite firing in relation to degree of fineness of fuel; results of investigation and conclusions. (Conclusions.)

SETTINGS. Effect of Flue-Dust on Boiler Linings, A. B. Searle. Steam Engr v 1 n 8 May 1932 p 340 and 350. Notes relating to effects of flue dust upon boiler refractories; methods by which destructive action of flue-dust may be reduced.

WATER COOLED. Les nouvelles chaudières R. L. de la centrale de Gennevilliers, J. Tissier. Revue Industrielle v 62 n 2275 June 1932 p 305–14. Four cooled side-wall types of water tube boilers at Gennevilliers power plant of Union d'Electricité illustrated and described; three made by Babcock & Wilcox and one by Als Thom; principal characteristics of auxiliary equipment listed.

WELDING. Geeignetes autogenes Schweissverfahren fuer den Kessel und Behaelterbau, H. Buchholz. Waerme v 55 n 22 May 28 1932 p 365–70. Autogenous welding process suitable for boiler and pressure-vessel manufacture; most important causes of boiler damages; comparison of riveted and welded joints; advantages and disadvantages of autogenous welds; welding process for increasing notched-bar toughness; stresses in welded joints.

Résistance des assemblages par cordons frontaux et latéraux soudés a l'électricité, E. Hoehn. Chaleur et Industrie v 13 n 144 Apr 1932 p 293–300. Determination and calculation of stresses in seams of electrically welded boilers and pressure vessels; tests, test results and analysis.

BOLTS AND NUTS

STRESSES. Ueber die Dauerfestigkeit von Schrauben, A. Thum and W. Staedel. Maschinenbau v 11 n 11 June 2 1932 p 230–2. Effect of design, manufacturing method and material on endurance strength of bolts and nuts on basis of tensile-impact tests at Technical University of Darmstadt.

BRIDGES

STEEL, DURABILITY. Ueber die Lebensdauer eiserner Bruecken (Stahlbruecken), F. Brunner. Montanistische Rundschau v 24 n 12 June 16 1932 (supp) p 2–5. Life of steel bridges; review of historical data, based on which average life of steel bridge is 50 to 100 years; comparison of maintenance costs of steel and reinforced-concrete bridges.

STEEL TRUSS. Bridges With Continuous Girders, G. Lindenthal. Civ Eng (N. Y.) v 2 n 7 July 1932 p 421–4. Half century of experience in American practice; first American developments; early types with controlled pier moments; various devices for continuity; more recent adaptions; example of Ross Island bridge.

C.P.R. Bridges Rebuilt for Heavier Traffic. Contract Rec v 46 n 24 June 15 1932 p 679–82. Strengthening and reconstruction of steel truss railroad bridge over Grand River on Galt Sub-Division, Ontario District, also of smaller bridges of Canadian Pacific Railway lines; false work design.

BUILDINGS

VIBRATIONS. Multiple Periods in Vibration of San Francisco Buildings. Eng News Rec v 108 n 25 June 23 1932 p 886. Observations on fifteen high structures show short-period movements in addition to fundamentals; marked vertical component observed in several of them.

CABLEWAYS

GREAT BRITAIN. Aerial Ropeway Installation. Engineer v 154 n 3990 July 1 1932 p 9–10. In connection with extensions to ammonia plant of Imperial Chemical Industries, at Dillingham, ropeway conveyor for main duty, combined with system of band conveyors was installed; carrying ropes are of double lock-coil construction, in which every wire is weight-bearing unit; whole installation is carried at height ranging from 50 to 90 ft above ground; buckets designed to carry net load of 35 cwt.

ITALY. La nuova funicolare a Napoli nel rione Sannazaro Posillipo, G. Loy Dona and F. Robutti. Ingegnere v 6 n 4 Apr 1932 p 239–47. Design, construction and equipment of funicular line in Naples, Italy, having curved alignment, rising 157 m in length of 557 m; construction of concrete line tunnels and culverts.

CARBURETORS

ADJUSTMENT. Scientific Adjustment of Carburetors, F. G. Baender. Motive Power v 3 n 5 May 1932 p 5–7 and 23–4. Practical discussion of underlying principles of gasoline combustion in automotive engines; table illustrating mileage increases resulting from scientific adjustment of carburetors on passenger cars; method of making analysis; graph showing relation between per cent carbon dioxide and miles per gal for passenger cars.

CARS, FREIGHT

MOTOR TRUCK TRANSPORTATION. Trucks for Milk Tank Trailers. Engineer v 153 n 3988 June 17 1932 p 675. Special trucks built by Great Western Railway at Swindon for carrying 2000-gal milk tank trailers; novel features introduced into truck and trailer, whereby weight is entirely removed from pneumatic tires when trailer is loaded in position on truck.

CARS, PASSENGER

AIR CONDITIONING. Air-Conditioned Train Inaugurated on C. & O. Ry Mech Engr v 106 n 5 May 1932 p 173–6 and 90. All passenger-carrying cars of "George Washington" are equipped for air conditioning; reproductions of historically famous paintings, and rare prints of Washington's time are unique features of decorations; details of air conditioning equipment together with schematic drawing of system, outstanding characteristics of sleeping and restaurant cars; power drive and control system.

CAST IRON

ALUMINUM. Influenza delle picolle aggiunte di alluminio alla ghisa grigia per getti, G. Sirovich. Metallurgia Italiana v 24 n 2 Feb 1932 p 83–98. Effect of small additions of aluminum to gray cast iron; interpretation of principal researches. Before Int. Foundry Congress.

CHIMNEYS

DRAFT. Motion of Gases in Smokestack, A. Zinzen. Mech Eng v 54 n 7 July 1932 p 507–8. Energy available for smokestack process manifests itself as pressure difference between top and bottom of stack; from this, author considers limiting conditions; first is when stack is completely shut off at bottom, but remains filled with gas; case of stack closed at top and filled with gas from below; relations are graphically presented. Previously indexed from Feuerungstechnik Mar. 15 1932.

COAL HANDLING

EQUIPMENT. Telescopic Chutes Solve Anthracite Coal Breakage Problem on O & W. Ry Elec Engr v 23 n 5 May 1932 p 112–14. Electric

control features of new type of loading equipment facilitate handling of coal; new chute has capacity of 1000 tons per hr; details of power supply and electric motor characteristics; operating features.

COAL LIQUEFACTION

UNITED STATES. Hydrogenation of American Coals. W. L. Beuschlein, B. E. Christensen and C. C. Wright. Indus & Eng Chem v 24 n 7 July 1932 p 747–51. Qualitative and quantitative data presented for hydrogen absorption by two American coals of bituminous class; temperatures between 300 and 350 C have been found to give optimum conversion of coals into phenol-soluble constituents; conversions of these coals at optimum conditions compare favorably with those reported for European coals.

CRANES

GIRDERS. Maximum-Stress Diagrams for Moving Loads on Crane Girders. W. Babbage. Mech Handling v 19 n 6 June 1932 p 207–9. Outline of method for calculating max stresses in members of lattice-type crane girder by use of max-stress diagrams; savings resulting from diagram methods.

SAFETY DEVICES. Safe-Load Indicator for Cranes. Engineering v 133 n 3466 June 17 1932 p 725; see also Engineer v 153 n 3989 June 24 1932 p 701. In case of derrick cranes, safe load varies with radius and indicator must be designed to show when crane is overloaded throughout working angle of jib; in Henderson indicator, this is effected by providing two pointers on register, position of one depending on actual load and of other on jib angle.

DIES

FORGING. Design and Care of Dies in a Job Forging Shop. H. R. Simonds. Iron Age v 130 n 1 July 7 1932 p 6–7 and (adv sec) 22. Die-making problems and economies at plant of Billings & Spencer Co.; experience in redesigning customers' products to effect reduction in cost of both dies and forgings.

MULTIPLE. Gang Dies. J. Langton. Mech World v 91 n 2372 June 17 1932 p 581–2. Dies which produce two or more pressings per stroke have been made necessary by demand for lower costs in mass production; how to obtain maximum number of blanks from minimum amount of stock, at same time permitting strong die construction and avoiding pressing of part blanks.

DIESEL ENGINES

DESIGN. Problems Connected With High-Speed Compression-Ignition Engines. H. B. Dicks. Aviation Eng v 6 n 6 June 1932 p 14–17. Means for utilizing to fullest extent oxygen available within cylinder and for avoiding production of smoke and noise; problem of obtaining high mep. Before Inst. Automobile Engrs.

ECONOMY. Diesel Locomotive Savings. A. H. Candee. Blast Furnace & Steel Plant v 20 n 6 June 1932 p 526–8. It is claimed average saving per hour of operation of Diesel as against steam locomotive amounts to $3.18; experience of Westinghouse Co. in use of Diesel-electric locomotives; advantages of latter.

FUEL INJECTION. Pump Characteristics Affect Diesel Engine Torque. P. M. Heldt. Automotive Industries v 66 n 22 May 28 1932 p 780–3. Delivery characteristics of valved and ported pumps; torque curves of Deisel engines using different combustion principles; effect of injection timing on torque curve.

MARINE. Doxford Engine Operation at Sea. Brit Motor Ship v 13 n 148 June 1932 p 102–3. Performance of 4-cyl 2900-bhp opposed-piston machinery during 400,000 mi service; main engine of standard Doxford design, each piston having stroke of 1160 mm, cyl diam 580 mm.

PULVERIZED FUEL. Igniton and Combustion Process in Coal Dust Engine. W. Wentzel. Fuel v 11 n 5 and 6 May 1932 p 177–93 and June p 222–8. Effect of density and temperature of combustion air, excess air, method of injection and particle size were investigated with experimental apparatus; dusts from various kinds of coal were used, effect of water-vapor content of combustion air and of particle size on combustion and ingition. Bibliography. Indexed in Engineering Index 1931 p 393, from Forschungsheft n 343 Apr 1931.

RECORDS. Remarkable Diesel Non-Stop Records. Diesel Power v 10 n 6 June 1932 p 262–3. Performance data of two Diesel engines; costs of operation and production of 365 hp Diesel engine-generator in Plant Elko Lamoille Power Co. Elko, Nevada, year 1931; oil consumption and cylinder wear.

VIBRATIONS. Isolating Machine Vibration and Noise. S. Rosenzweig. Diesel Power v 10 n 5 May 1932 p 199–201. General and theoretical considerations involved in study and prevention of vibration transmission and means available for its effective isolation; photographs and outline drawings of foundations prepared for 2865 hp McIntosh & Seymour Diesel engine that is being installed in municipal electric light plant Rockville Center, Long Island, N. Y. Before Eng. Inst. Canada.

[See also *Airplane Engines, Internal-Combustion Engines.*]

DRILLING MACHINES

HYDRAULIC DRIVE. Hydraulic Multiple Drilling Machine. Engineering v 134 n 3468 July 1 1932 p 25. Machine made by National Automatic Tool Co., Richmond, Ind., with view to increasing production rates and lowering operating costs; specially designed for fixed center multiple drilling; cluster box can be easily changed to suit each individual job; hydraulic feed system is supplied from pump of plunger type which delivers oil at pressure of 1000 lb per sq in.

DRILLS

TWIST. Twist Drills and Materials From Which They Are Made. W. R. Breeler. Machy (N. Y.) v 38 n 10 June 1932 p 742–7. Physical properties, composition and heat treatment of principal steels including low-tungsten steels, cobalt high-speed steels and nitriding steels; recommendations for use of tungsten-carbide tipped drills, stellite drills and chromium-plated cutting edges for drills.

DROP FORGING

TIME STUDY. Bestimmung der Arbeitszeiten beim Gesenkschmieden. M. Zscheile. Maschinenbau v 11 n 11 June 2 1932 p 228–9. Application of time study with particular regard to determination of standard time for principal operations; numerical examples.

ELECTRIC FURNACES

MELTING. Four-Ton Coreless Induction Furnace Intalled. D. Willcox. Steel v 90 n 22 May 30 1932 p 23–4. Layout and operation of furnace capable of melting 40 to 50 tons of steel per day.

ELECTRIC WELDING

ARC. Erkenntnisse und Erfolge bei der elektrischen Schweissung. W. Prox. VDI Zeit v 76 n 21 May 21 1932 p 497–504 1 supp plate. Investigation of physical properties and structure of electric arc welds with particular regard to effect of annealing; value of various testing methods and dimensions of test specimens; influence of welding on layout of high-pressure vessels and other highly stressed machine parts.

ELEVATORS

ELECTRIC MOTORS. Alternating-Current Motors for Elevator Operation. C. P. Hamilton. Power v 75 n 25 June 21 1932 p 915–17. Consideration of such problems as effects of starting current on voltage regulation, noise produced by motors and effects of unbalanced voltage on this noise, and use and control of multi-speed induction motors; points discussed in article also applicable to general use of a-c motors in buildings.

FITS AND TOLERANCES

STANDARDIZATION. Toleranzen Grosser Durchmesser. N. N. Sawin. Werkstattstechnik v 26 n 10 May 15 1932 p 193–4. Suggestions for international standardization of tolerances for large diameters on experimental basis.

FLOW OF FLUIDS

MEASUREMENT. Orts-, Fern- und Summenzaehlung stroemender Mengen industrieller Stoffe mittels mechanischer Zaehlwerke. H. Lohmann. Waerme v 55 n 23 June 4 1932 p 381–3. Stationary, remote and total recording of flow of materials by means of mechanical counters; flowmeter according to U-tube principle with mercury filling for measurement of liquids, steam, air, and gas; flow recorder based on principle of float meter with built-in mechanical counter; pyramid differential gear of summation meter.

FLOW OF STEAM

PIPE. Chart for Pressure Drop in Low-Pressure Steam Piping. J. Hulman. Heat Piping and Air Conditioning v 4 n 5 May 1932 p 343–5. Method of using chart in determining quantity of steam flowing in pipe under various conditions; correction factor enables use with higher pressures; specific example.

FURNACES, ANNEALING

CONTINUOUS. Mechanischer Ofen zum Gluehen und Vergueten von Mittel- und Grobblechen. H. Fey. Stahl und Eisen v 52 n 25 June 23 1932 p 617. Mechanical furnace made by OFAG Co., Duesseldorf, for annealing and heat treating sheets of 8 to 120 mm thickness; continuous furnace with stationary roller hearths is heated with blast-furnace gas and so designed that cold sheets can be introduced into furnace on refractory pillars, so that they may be thoroughly heated on all sides, especially at bottom.

FURNACES, MELTING

PULVERIZED COAL. Working of Rotary Pulverized Fuel Fired Melting Furnaces. W. Scott and S. E. Dawson. Foundry Trade J v 46 n 824 June 2 1932 p 335–7 (discussion) 337–8. Practical considerations, W. Scott; objects of rotary furnace; design; kinds of coal used; raw materials; melting times; battery of four furnaces and personnel required; practical examples of castings. Metallurgical considerations, S. E. Dawson. Before Inst. Brit. Foundrymen.

FURNACES, METALLURGICAL

REGENERATORS. Waermeaustauscher aus Edelstahl. K. Rummel. Stahl und Eisen v 52 n 23 June 9 1932 p 559–62. Heat exchangers made of heat-treated steel; advantages of steel over brick recuperators for preheating; savings effected by preheating for roll-mill, forging and annealing furnaces.

GEAR CUTTING

SHAPER. Use of Gear Shaper in Plant Repair Shop. F. A. Westbrook. Melliand v 4 n 2 May 1932 p 103–4. By properly organizing shop it is usually quicker to replace damaged gear by making it instead of waiting for one to be shipped; types of gears which can be cut by modern gear shaper.

GEARS

WORM. Efficiency of Worm Gear. H. Walker. Machy (Lond) v 40 n 1025 June 2 1932 p 261–3. Design and performance of Holroyd-Walker gear employing special shape of tooth generated on parallel worm; wheel tooth being made conjugate to worm thread; results of tests at National Physical Laboratory show efficiency of up to 98.7%.

GRINDING MACHINES

SURFACE. Automatic Surface Grinding Machine. Engineer v 154 n 3990 July 1 1932 p 20. New horizontal spindle grinder developed by A. A. Jones and Shipman; wheelhead spindle is made from nickel-chrome steel, and is carried in long adjustable phosphor-bronze bearings.

TESTING. Inspection and Testing of Machine Tools. G. Schlesinger. Machy (Lond) v 40 n 1022 and 1024 May 12 1932 p 182–5 and May 26 p 243–6. Testing charts for cylindrical and planer-type surface grinders and universal tool and cutter grinders with data on permissible errors and tolerances for prinicpal parts of machines. Translated from Pruefbuch fuer Werkzeugmaschinen.

HAMMERS

PNEUMATIC. Motor Driven Air Hammers. H. A. Weyer. Heat Treating and Forging v 18 n 5 May 1932 p 299–302. Method for calculating and checking air hammers; diagram of velocity and stroke; selecting size of hammer.

HEAT EXCHANGERS

MANUFACTURE. Holding Power and Tightness of Heat Exchanger Tubes. C. O. Sandstrom. Chem & Met Eng v 39 n 6 June 1932 p 323–5. Results of tests; specimens were 3/4-in., 18-gage admiralty-metal tubes rolled into 49/64-in. drilled holes in 3/4-in. plates simulating tube sheets; tube holes were drilled but not reamed; greater tests and much practical experience seem to justify belief that rolled tubes are very effective stays; fluid-tightness tests.

HOISTS

ELECTRIC. Workshop Handling Equipment. F. E. Chilton. Elec Rev v 110 n 2847 June 17 1932 p 893–4. Equipment generally governed by three prime factors; nature of product, capacity for production, and architectural facilities; notes on speed control, potentiometer control, and braking of a-c motors.

HYDRAULIC TURBINES

Hydraulic Turbines. F. J. Taylor. Elecn v 108 n 2820 June 17 1932 p 829–32. Propeller type machines for low and variable falls; runner of Voith propeller type turbine; section of Dubs (Escher-Wyss runner of turbine to run at 107 rpm on 14 ft fall; curves of Lilla Edet turbines; details of Morgan Smith blade moving mechanism.

HYDROELECTRIC POWER PLANTS

CALIFORNIA. New Merced Falls Hydroelectric Plant on Merced River. H. K. Fox. Universal Engr v 55 n 5 May 1932 p 19–22. New development of Merced Falls Plant consists of concrete dam and spillway, 20 ft high and 560 ft long, concrete intake structure, concrete spiral scroll case

and elbow type draft tube, hydraulic turbine and direct connected vertical type electric generator, oil storage house and substation; details of equipment and constructional methods; plant contains first outdoor generating unit in California.

RECONSTRUCTION. Modernizing Trollhaettan—Sweden's Largest Hydro Plant, G. Willock. Power v 75 n 25 June 21 1932 p 918–20. Rebuilding 12,500-hp, horizontal-shaft Francis-type turbine operating under 100 ft head increased its max rating to 17,800 hp and raised its efficiency from 86 to max of 91.6%; efficiencies at different hp loads of old and new unit; cross-section of new 17,800-hp turbine.

IMPACT TESTING

BENDING ENDURANCE. Der Dauerschlagbiegeversuch-Abhaengigkeit der Schlagzahl von Fallgewicht und Fallhoehe, M. Beilhack. Forschungsheft v 3 n 354 May/June 1932 22 p price 5 rm. Impact endurance bending test; by application of comprehensive experimental and theoretical research, writer has succeeded in analyzing process involved in impact endurance test, and in demonstrating influence of drop weight and height of drop upon number of shocks required to induce failure.

INTERNAL-COMBUSTION ENGINES

DETONATION. Calcul d'une limite supérieure de la durée de la détonation dans les moteurs a explosion et explication de la présence d'une lacune dans les diagrammes fournis par certains manographes électriques, M. Serruys. Académie des Sciences—C R v 194 n 22 May 30 1932 p 1894–6; see also Génie Civil v 100 n 25 June 18 1932 p 624–5. Calculation of upper limit of duration of detonation and explanation of break in diagram obtained by certain electric pressure recorders.

STANDARDIZATION. Does Optional Equipment Permit Standardization? H. F. Shepherd. Machine Design v 4 n 5 May 1932 p 27–30. Example of designing internal combustion engine so that various components can be exchanged in accordance with requirements of different types of service and fuels.

WASTE-HEAT UTILIZATION. Steam From Exhaust Heat. Power Engr v 27 n 315 June 1932 p 227–8. Notes on recovery of heat from exhaust gases of internal-combustion engines; diagram of heating and ventilating system operating with exhaust heat of oil engine.

[See also *Airplane Engines; Diesel Engines.*]

LOCOMOTIVES

BOOSTERS. Rebuilt 0-8-4 Tank Engine, fitted With Reversible Booster, L.N.E.R. Locomotive v 38 n 478 June 15 1932 p 193–5. Leading dimensions and ratios of engines as rebuilt; tractive power of engine at 85% boiler pressure, without booster, 34,523 lb, and with booster in operation this is increased by 12,373 lb, making total tractive effort of 46,896 lb; arrangement of reversible booster.

COMPOUND. New Locomotives and Accelerated Services, Great Northern Railway of Ireland. Ry Gaz v 56 n 23 June 3 1932 p 817 and 821. Cylinders, high pressure 17¼ by 26 in.; low pressure 19 by 26 in.; coupled wheels 6 ft 7 in.; boiler pressure 250 lb per sq in.; tractive effort at 80% boiler pressure referred to lp cyl 23,762 lb; total weight of engine and tender in working order 103 tons; total engine wheel base 24 ft 9 in.

DESIGN. Noteworthy French Locomotive Development. Ry Engr v 53 n 629 June 1932 p 225–8 1 supp plate. 44-cyl compound superheated 4-8-2 express locomotives of new design have been placed in service on Chemin de Fer del'Est; constructional features; new type of engine and tender coupling; diagrams illustrating locomotive design; dimensional details.

TANK. 2-10-2 Three-Cylinder Tank Locomotives, Eastern Ry. of France. Locomotive v 38 n 477 May 14 1932 p 157–9. Review of general characteristics together with various design features; cylinders 22.05 by 25.98 in.; coupled wheels 4 ft 5.15 in.; boiler pressure 203.1 lb per sq in.; weight of engine empty 97.6 kg-tons.

LUBRICATION

VISCOSITY. Le graissage rationnel, H. Brillie. Science et Industrie v 16 n 219 Apr 1932 p 139–50. Question of viscosity phenomena and of oil films was little studied in France until recent years; after indicating manner of investigation to solve certain lubrication difficulties which presented themselves in operation of thrust bearings in large liners, author describes new and chiefly geometric study of viscosity phenomena; study leads to simple theory on oil film.

MACHINE TOOLS

EXHIBITION AT LEIPZIG. Die Werkzeugmaschinen auf der Leipziger Technischen Messe 1932, O. Rambuscheck, Werkstattstechnik v 26 n 9, 10 and 11 May 1 1932 p 173–80 May 15 p 194–9 and June 1 p 214–18. Design and performance of representative exhibits including lathes, screw machines, boring machines, milling machines, grinding machines, saws, planers, broaching machines and presses.

EXHIBITION AT PARIS. Les machines-outils françaises à la foire de Paris. Science et Industrie v 16 n 220 May 1932 p 201–8. Various types of metal working machinery exhibited at Paris fair.

STANDARDIZATION. 11 collaudo delle macchine utensili, C. A. Cavalli. Industria Meccanica v 14 n 2, 3 and 4 Feb 1932 p 85–92 Mar p 182–9 and Apr p 237–51. Progress in principal phases of standardization including cooperation of manufacturers, errors and tolerances, use of measuring instruments, etc.; Schlesinger test charts for milling machines, gear cutting machines and lathes.

MACHINERY

STANDARDS. British Engineering Standards and Foreign Markets, D. A. Brenner. Engineer v 153 n 3986 June 3 1932 p 619–20. Reply to letter from British Chamber of Commerce in Buenos Aires to British Standards Institution, asking if lowering of British standards could be considered with view to South American market; it is maintained any actual degradation of standards and debasement of British machinery might be suicidal but improvements in design, better selection of materials, reduction of extravagant safety factors and weights may result in economies without sacrifice of quality.

MATERIALS HANDLING

EQUIPMENT. Ratability of Mechanical Handling Machinery, T. S. Dulake. Mech Handling v 19 n 5 May 1932 p 169–71. General review of factors pertaining to ratability of handling machinery.

MATERIALS TESTING

SPECIFICATIONS. Material Specifications and Research at A.S.T.M. Meeting. Eng News-Rec v 108 n 26 June 30 1932 p 923–7. Review of proceedings of 1932 meeting; brief abstracts of papers and specifications on medium structural steel, wrought iron, cast iron, malleable iron, cement, rivets and reinforcing bars, road materials, timber preservatives, etc.; corrosion of iron and steel; testing zinc coatings; brittleness in galvanized structural steel; fatigue of metal; welding cast and rolled steel; baked-enamel pipe coatings; concrete-mix design; test methods and equipment.

METALS CUTTING

WEAR OF EDGE. Zerspanungsuntersuchungen als Kurzverfahren fuer den Betrieb, W. Leyensetter. Maschinenbau v 11 n 11 June 2 1932 p 221–3. Factors controlling wear of cutting edge for light and heavy cuts; use of pendulum method for determining wear of cutting edge in making light cuts of different materials.

MILLING CUTTERS

TUNGSTEN CARBIDE. Determining Value of Tungsten-Carbide Milling Cutters—II, B. P. Graves. Machy (N. Y.) v 38 n 10 June 1932 p 761–3. Recommended speeds and feeds for milling; results of tests on 9-in. tungsten-carbide tipped face mills; use of tungsten-carbide tools in automatic screw machines.

MILLING MACHINES

HIGH SPEED. High-Speed Milling Machine. Engineering v 133 n 3467 June 24 1932 p 753. Series of machines having spindle speeds up to 1000 rpm and feeds up to 100 in. per min introduced by Kearney and Trecker Corp., Milwaukee.

STANDARD. Development of Standard Milling Machines, E. Hanf. Eng Progress v 13 n 6 June 1932 p 126–9. Design of milling machines built by Wandererwerke A. G., Chemnitz, with particular regard to frame drive, and increased speeds and feeds.

VERTICAL. American Milling Machine. Engineer v 153 n 3987 June 10 1932 p 646. Vertical spindle machine made by Sleeper and Hartley of Worcester, Mass.; in outward appearance it resembles planer-type miller, but in actual fact table is stationary, while columns travel along ways on bed.

NITRIDATION

ABSORPTION. Nitriding of Iron and Its Alloys—1, A. W. Coffman. Indus & Eng Chem v 24 n 7 July 1932 p 751–4. Ammonia dissociation and nitrogen absorption in nitriding process.

NON-FERROUS METALS

SECONDARY. Bessemerization of Bell Bronze. J. B. Kasey. Metal Industry (N. Y.) v 30 n 5 May 1932 p 185–6; see also Metal Industry (London) v 40 n 24 June 10 1932 p 613–14. Separation and recovery of copper and tin metal; experiments with various fluxes in smelter in Soviet Russia.

OIL ENGINES

CASTINGS. Fractures in Casting of Gas and Oil Engines, E. Ingham. Mech World v 41 n 2370 June 3 1932 p 538–40. Fractures may be caused by poor design or by improper working conditions; faults in design usually lie in omission to make allowance for unequal expansion of various parts; most important factor in prevention of overheating is use of pure circulating water.

OSCILLOGRAPHS

CATHODE RAY. Circular Time Base Giving Radial Deflections, for Use With Cathode-Ray Oscillographs. Instn Elec Engrs—J v 71 n 426 June 1932 p 82–5. Electromotive force, under examination, is caused to modulate two voltages applied in quadrature to plates of oscillograph; resultant screen-image on oscillograph consists of circular time-base, on which are superposed radial deflections delineating wave-form and time relationships of applied electromotive forces.

PHOTOELASTICITY

DEVELOPMENT. Fortschritte auf dem Gebiet der spannungsoptischen Untersuchung von Konstruktionen, L. Foeppl. VDI Zeit v 76 n 21 May 21 1932 p 505–8. Review of theoretical principles and recent progress in technique of photoelastic analysis of stresses in models of structural elements, with special reference to work done at Munich Institute of Technology; prospects of future development.

PHOTOELECTRIC CELLS

INDUSTRIAL APPLICATIONS. Industrial Applications of Photo-Electric Cell, G. W. Stubblings. Mech World v 91 n 2373 June 24 1932 p 610–12. Control of lighting; counting of objects which are too light or numerous to be handled efficiently; smoke detection; fire extinction and alarm; control of machinery.

Photronic Photo-Electric Cell and Some Typical Applications, M. B. Hastings. Hydro-Elec Power Commission Ontario—Bul v 19 n 6 June 1932 p 181–7. Weston photoelectric cell "Photronic" is result of intensive research on part of Weston Electrical Instrument Corp.; applications of Photronic photoelectrical may be divided into two classes, direct and indirect, characteristic equipment. Before Assn. Mun. Elec. Utilities.

PHOTOMETERS

PHOTOELECTRIC. Ueber das Wesen der Photozelle und ihre Anwendung in der Messtechnik, etc G. Gollnow. Chemische Fabrik v 5 n 20 May 18 1932 p 161–3. Character of photo cells and their use in measuring technique; automatic electric photometer for light-absorption measurements, opacity, color, etc.

PIPE

CAST-IRON JOINTS. Self-Adjusting Pipe Joint, F. W. O. White. Gas J v 198 n 3603 June 8 1932 p 575–6. Review of new developments to meet modern conditions, with special reference to gas mains in cities and towns.

CAST-IRON SPECIFICATIONS. Deutscher Normenausschuss, e. V. Normblattentwurf DIN E 2420 Gusseiserne Rohre und Formstuecke Technische Lieferbedingungen. Gas- und Wasserfach v 75 n 15 Apr 9 1932 p 287–8. Text of tentative German standards for acceptance tests of cast-iron pipe and metals.

FITTINGS. Pipe Fittings Used in Power Plants, H. C. Moffett. Power Plant Eng v 36 n 13 July 1 1932 p 523–5. Consideration given to metals and alloys used in manufacture of fittings; physical and chemical characteristics and fitness for service; standards.

PISTON RINGS

MANUFACTURE. Piston Ring Manufacture. Automobile Engr v 22 n 293 May 1932 p 217–21. Production methods and equipment used in making radial direct-pressure rings at Wellworthy works; inspection and testing of rings for compression pressure and thickness; tolerances for principal machining operations.

PLYWOOD

TESTING. Tests Made to Increase Durability of Plywood, D. Brouse. Furniture Mfr v 43 n 6 June 1932 p 33–6. Effect of preservatives on durability of glue joints made with casein glue and exposed to relative humidities between 95 and 100%; experiments with plywood joints; treatment with creosote; results of tests; wood decay.

PRESSURE VESSELS

WELDING. Lichtbogenschweissung statt Wassergasschweissung, C. Massmann. Elektroschweissung v 3 n 5 May 1932 p 96–8. Arc welding vs water-gas welding; discussion of quality of welds and suitability of process applied to pressure vessels on basis of various mechanical strength tests.

PULVERIZED-COAL

FIRING. Pulverized Fuel Firing, P. B. Jackson. Elecn v 108 n 2820 June 17 p 838–40. Survey of present position with special reference to power station practice; influence on development of steam generators. Before Inst. Mar. Engrs.

PRODUCTION CONTROL

SMALL PLANTS. Production Control in Small Plant, A. H. Sulger. Nat Assn Cost Accountants—Bul v 13 n 19 section 1 June 1 1932 p 1330–3. Discussion of several production methods employed by cosmetic manufacturer, together with high spots in this industry.

PUMPS

CENTRIFUGAL. Development of Turbine Well Pumps, D. J. Conant. Can Engr v 62 n 23 June 7 1932 p 15–16 and 40. Principal characteristics of impulse, reaction and mixed flow centrifugal pumps; principal parts of pump; hydraulic thrust. Before annual convention of Am. Water Works Assn.

ROTARY. Untersuchungen an einer Kapselpumpe, F. Kluge. VDI Zeit v 76 n 25 June 18 1932 p 609–12. Mechanical details and operating features of rotary pump of Sphaero design; performance and efficiency curves; results of tests.

TURBO-ELECTRIC. Turbo-Electric Feed Pump. Engineer v 153 n 3988 June 17 1932 p 673. G. and J. Weir installed plant at Spondon power station capable of delivering 50,000 gal per hr against boiler pressure of 350 lb per sq in.; plant consists of two pumps connected in series, larger and more powerful of which is driven by electric motor, while smaller is turbine driven; effect of combining two pumps is shown in curve.

RAILROADS

OPERATION IN GREAT BRITAIN. British Railways Show Fight, C. S. Lock. Ry Age v 92 n 23 June 4 1932 p 953–6. Review of British railway operations for 1931, with particular emphasis on economies effected and development of complete transportation services on rail and highway.

TRACK TESTING. Automatic Recording Machine for Track Defects. Ry Gaz v 56 n 22 May 27 1932 p 774–7. Details of device which is practical contribution to efficient permanent way maintenance; charts are presented which were obtained from recorder; operating methods.

TRAIN SPEEDS. Great Western Record, H. Baker. Engineer v 153 n 3987 June 10 1932 p 638; see also editorial comment p 641–2. On June 6th, two remarkable runs were made from Swindon to London and back by up-and-down Cheltenham Spa Expresses of Great Western Railway; 3:48 p m train made average of 81.6 mph throughout, while down train made average of 77.3; record of logs.

RAILS

DESIGN. Spurkranz und Schienenkopf, Heumann. Organ fuer die Fortschritte des Eisenbahnwesens v 86 n 23 and 24 Dec 1 1931 p 471–80 and Dec 15 p 491–9. Theoretical design of rational form of rail cross-section; geometry of contact between wheel flanges and rail head on curves; one-point and two-point contact; contact after wear has occurred.

FLAW DETECTION. Detection of Internal Fissures in Rails, C. J. Allen. Ry Engr v 53 n 628 May 1932 p 176–9. Notes on Sperry detector car, now widely used on railways of United States and Canada for electrical detection *in situ* of fissure defects in rails; characteristics of Sperry detection methods; graph showing transverse fissure failures of future trend; results achieved.

REFRACTORY MATERIALS

HEAT EXPANSION. L'expansion des refractaires. Revue des Matériaux de Construction et de Travaux Publics n 269 Feb 1932 p 75–6. Expansion of refractories; continuous expansion from room temperature up to highest reached is shown in curves.

HEAT TRANSMISSION. Untersuchungen ueber das Waermeleitvermoegen feuerfester Steine, A. Kanz. Mitteilungen aus dem Forschungs-Institut der Vereinigte Stahlwerke Aktiengesellschaft Dortmund v 2 n 10 1932 p 223–34. Investigations of head conductivity of refractory materials; new testing method and equipment; with this so-called single-plate process, heat conductivity of various types of refractory materials was determined, results of which are given.

REFRIGERATION

FOOD PRODUCTS. Dry Ice in Distribution of Frozen Foods, W. D. Mount. Refrig Eng v 23 n 6 June 1932 p 353. General discussion of increasing popularity of dry ice in frozen food transportation; simplicity of cold storage by means of solid carbon dioxide.

ROLLING MILLS

STRAIGHTENING SHOPS. Betriebswirtschaftliche Untersuchung in einer Zurichterei, K. Veit. Stahl und Eisen v 52 n 22 June 2 1932 p 544–5. Analysis of performance in a straightening shop, operating under difficult conditions, and in which workmen were paid on group bonus system; method of cost accounting.

SCREW MACHINES

AUTOMATIC. How Automatic Machines Are Made Truly Automatic, C. O. Herb. Machy (N. Y.) v 38 n 10 June 1932 p 721–6. Layout andoperation of automatic loading equipment developed by Seneca Falls Machine Co., Seneca Falls, N. Y.; application in machining of steering gear parts at New Castle, Ind., plant of Chrysler Corp.

SHEET-METAL

CUTTING. Schneiden und Bearbeiten von Eisen- und Stahlblechen in kaltem Zustande, H. Wilhelm. Maschinenbau v 11 n 10 May 19 1932 p 210–13. Investigation of effect of cold cutting of steel on physical properties of edges of sheet, with particular regard to methods of eliminating harmful hardening; advantages of machining and oxyacetylene cutting.

HEAT TREATMENT. Manufacture and Heat Treatment of Sheet and Strip Steels—V, E. F. Davis. Fuels and Furnaces v 10 n 6 June 1932 p 399–400 and 404. Concluding remarks pertaining to kinds of steels used for sheet and strip; grading of sheet steel.

TIN PLATE. Combination System, R. J. Wean and H. Melin. Iron and Steel Engr v 9 n 5 May 1932 p 207–13. Development and modern operating principles of mills making sheet or tin plate according to combination method comprising continuous furnace, sheet mill, conveyor from furnace to mill, mechanical means of handling metal during rolling, return conveyors from mill to furnace, automatic doubler and automatic top and bottom roll polishers. Before Assn. Iron and Steel Elec. Engrs.

SHIP PROPULSION

DIESEL VS STEAM. Diesel and Steam Discussed at N. Y. Propeller Club. Motorship v 17 n 6 June 1932 p 223 and 240–1. Discussion by L. R. Ford and J. H. King; Diesel no longer experiment; question of fuel; performance of MS Daylight. Before Propeller Club Port N. Y.

STEAM ENGINE AND TURBINE. Waermetechnische Betrachtungen ueber Abdampfturbinen, Etc., G. Bauer. Schiffbau v 33 n 9 and 10 May 1 1932 p 131–5 and May 15 p 151–4. Therma study of exhaust-steam turbines and other improvements for reciprocating engines; comparison of different exhaust-turbine systems; other measures introduced for increasing efficiency of steam engines, including improvement of boiler water circulation, increase of super heating, steam bleeding, increase of vacuum, use of Lentz poppet valve gears, etc.

SLIDE RULES

IMPROVED. Modern Slide Rule, H. O. Cooper. Engineer v 153 n 3988 June 17 1932 p 658–9. Slide rule considered is fitted with usual A, B, C, and D scales, log-log-scale, and it may have scales for voltage drop and efficiencies of dynamos and motors; in addition, newer slide rules carry reciprocal scale and scale of cubes.

SMOKE ABATEMENT

NEW JERSEY. Fighting Smoke in Hudson County, New Jersey. Ry Age v 92 n 23 June 4 1932 p 941–3. Cooperation of railroads with Department of Smoke Regulation has been important factor in establishing good-will toward rail transportation; results of smoke observations from locomotives; results of observations of smoke jacks on enginehouses; floating equipment.

SPRING STEEL

TESTING. L'essai de torsion élastique des fils d'acier pour ressorts, Bonzel. Revue de Métallurgie v 29 n 5 May 1932 p 229–37. Elastic torsion test of steel wire for springs; examples of diagrams of torsion; it is concluded that this test is much better adapted to control of spring-steel wire than tension test, as it indicates more accurately good and bad properties of this material; its adaptation in standard specifications is recommended.

STEAM

HIGH PRESSURE. Thermische Zustandsgroessen des ueberhitzten Wasserdampfes bei hohen Druecken, W. Koch. Zeit fuer Technische Physik v 13 n 6 1932 p 263–6. By means of equation for specific heat of superheated steam at constant high pressure, various specific heat data are determined and compared with experimental results obtained in England and United States; comparison with International Steam Table Conference.

Higher Steam Pressures and Temperatures. Nat Elec Light Assn—Publ n 220 May 1932 13 p. Report compares performance records from five 600 lb, three 1200 lb superimposed and three straight 1200 lb stations; there are also included availability and use records for twenty-two 1200 lb boilers and discussions of 1000/3500 lb experimental boiler and 1200 lb 825/850 lb cycle. Bibliography.

STEAM CONDENSERS

SURFACE. Large Surface Condenser. Engineer v 153 n 3987 June 10 1932 p 648–9. Ingersoll-Rand condenser supplied to Brooklyn Edison Co. to serve additional turbo-generator installed at station; design is characterized by heart-shape cross-section with subdivision on steam side into four horizontal banks extending across condenser and into five compartments along length of condenser.

STEAM PIPE LINES

CORROSION. Return Line Corrosion, E. P. Schinman. Power Plant Eng v 36 n 12 June 15 1932 p 491–3. Consideration of main causes of pipe line corrosion; most important of which is oxygen; deaeration of feedwater; live steam heating; large size, steep pitch and proper trapping essential; protecting return lines by feeding oil.

UNDERGROUND. Underground High-Pressure Steam Piping, J. E. Hillemeyer. Heat Piping and Air Conditioning v 4 n 5 May 1932 p 354–5. Review of constructional details illustrating high-pressure underground steam pipe line progress; location of tile block; placing high-pressure traps in separate manholes.

STEAM POWER PLANTS

EFFICIENCY. Setting up Bogie for Power Plant Efficiency, M. F. Merl. South Power J v 50 n 6 June 1932 p 23–7. Setting up probable performance of power plant in advance permits ready detection of conditions causing sudden drops in efficiency; calculation of actual efficiency, bogie efficiency, auxiliary power and btu per kw-hr output of station.

FOUNDATIONS. Power Plant Foundations, O. VonVoigtlander. Power v 75 n 24 June 14 1932 p 881–4. Huge sums expended in building steam generating stations make it imperative that considerable thought be given to plant foundations; necessities for adequate substructure; foundation problems and their solutions.

GREAT BRITAIN. Thornhill Power Station. Elecn v 108 n 2820 June 17 1932 p 842–3. Station capacity is now 67,000 kw, of which two 6000 kw B.T.-H machines and their boilers are reserved for standby service; simplicity to keynote of design of station, as favorable prices at which it is possible to purchase coal do not justify refinements which would be desirable in districts where coal is more costly.

HEATING AND POWER. Distribution of Costs in Combined Heating and Power Stations. Steam Engr v 1 n 8 May 1932 p 351–3. Consideration of advantages of combining power and heat services; major problem of arriving at reasonable division of variable operating costs; reference made to numerical example of costs.

HIGH PRESSURE. Betriebserfahrungen in dem 120 at Kraftwerk der Ilse Bergbau-A.G., Grube Ilse, O. Schoene. Archiv fuer Waermewirtschaft v 13 n 6 June 1932 p 141–8. Operating experiences in 120-atm power plant of Ilse coal mine, Germany; properties of metal at temperatures exceeding 450 C; idle periods of boilers; accustoming men to operate with high pressure; oil content of condensate; composition of boiler sludge; oxygen content of feedwater; water circulation; flexibility in boiler design; fluctuations of pressure; elimination of air preheaters.

High Steam Pressures and Temperatures in France. Steam Engr v 1 n 8 May 1932 p 336–9. Brief review of general tendency toward superpower station practice in France; details of St. Denis Power Station extensions.

IRON AND STEEL PLANTS. Combustion Control for Steel Plant Boilers, T. A. Peebles. Blast Furnace & Steel Plant v 20 n 6 June 1932 p 519–22. Combustion-control installations in steel mills have been developed to high degree of effectiveness; steel-plant fuels; simultaneous charts of steam temperature and pressure delivered by pressure-reducing and desuperheating station in